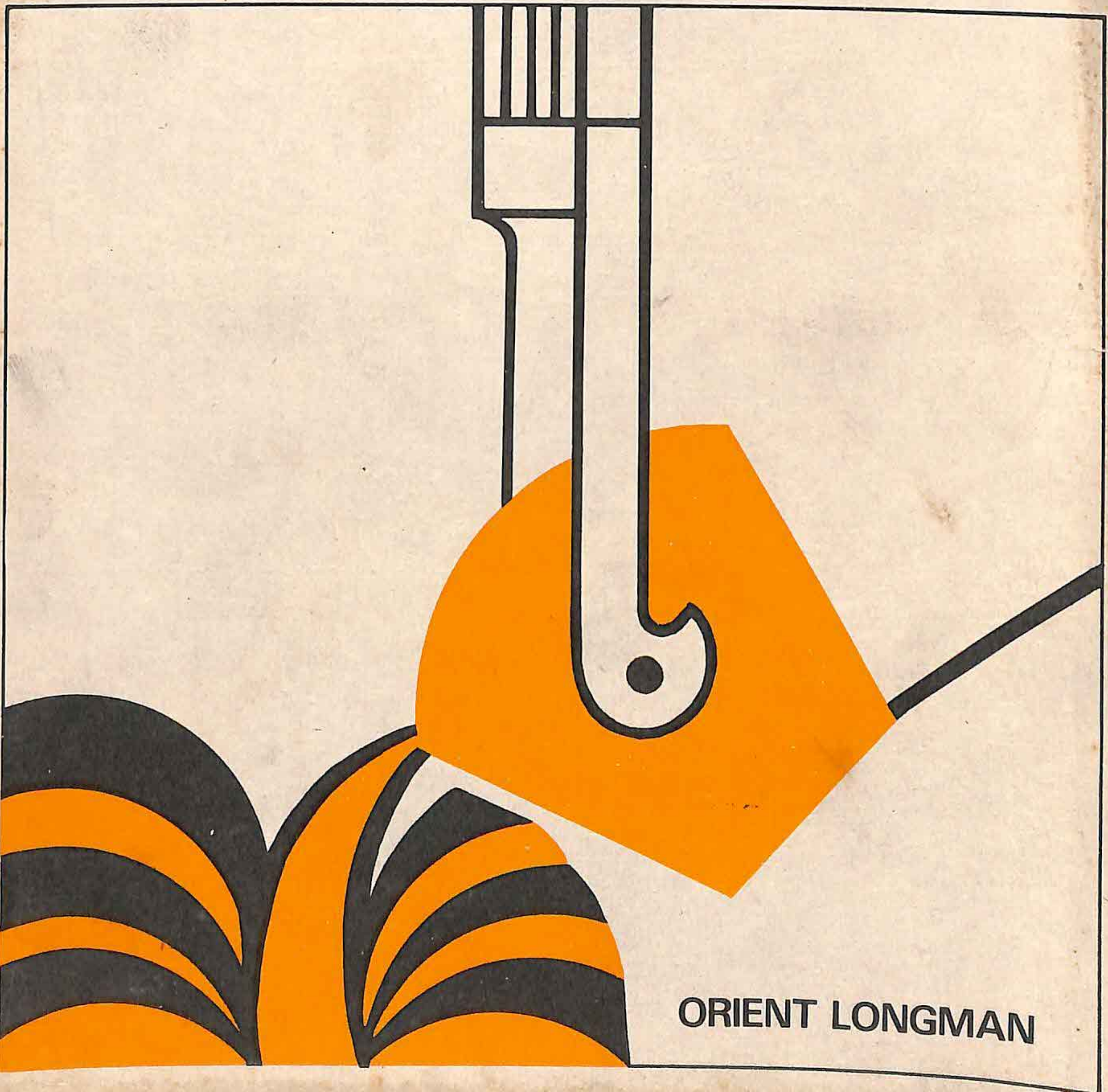
THE WORLD AROUND US

5

ENVIRONMENTAL SCIENCE FOR PRIMARY SCHOOLS



ORIENT LONGMAN

SOME BASIC TEACHING ASSUMPTIONS FOR THE SERIES

1 Knowledge is meaningful only when facts are made real to a child through experience. He thus learns not through passive listening and note-taking but through talking, perceiving and participating in activities related to the experience.

2 Basic intellectual and scientific skills must be developed – observation, reasoning, judgement, anticipation and curiosity.

3 The child must not be prejudiced but guided. Therefore, except on essential issues, judgements on facts and situations are not imposed.

4 The environment is too vital to be ignored. The emphasis should be on conserving the natural world and on developing attitudes of involvement and concern.

5 Children must express themselves – in words, in writing, in activity – and they must be given opportunities to do so.

6 There are usually a number of possible answers to a question, including the honest 'I don't know'. Children must be directed to the most satisfactory answer by hints and pointers, not a dismissing 'right' and 'wrong'.

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THE WORLD AROUND US

BOOK 5

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ORIENT LONGMAN

BOMBAY CALCUTTA MADRAS NEW DELHI
BANGALORE HYDERABAD PATNA

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TO THE TEACHERS

The World Around Us is a set of six books of environmental science for primary schools. The environment physically presented is Indian, with features familiar to every Indian child.

The material is based on the topics listed and the emphases recommended in the recently revised syllabus of the National Council of Educational Research and Training (NCERT). Due attention has however been given to absorbing the recommendations in other primary-level syllabuses as well.

The series represents an effort to promote certain elements of thinking which are today recognised as crucial in teaching the environmental sciences. The environment is a dynamic, living, *changing* phenomenon. As human beings capable of thinking, doing and inventing, we exert the greatest influence on it. Man-made complexities and problems in modern living make it necessary for us to develop positive attitudes of concern for the environment and the desire to conserve its natural endowments and resources.

The material is organised, as it is in the NCERT syllabus, under concept-heads with reference to the home and the family, the neighbourhood, the school and the outer world of space. A number of subjects are covered. The texts are profusely illustrated. Lessons have been planned and presented with a view to stimulating the child's interest and curiosity.

A special feature is the help offered to the teacher. In the Introductory Book and Books 1 and 2, this is in the form of detailed notes for each lesson. In the later books, teaching guidelines are built into the text and are self-evident. The teacher is of course free not to use the notes and to evolve his or her own methods of teaching. The teacher is also advised to repeatedly supplement the material in these books with activities that draw the child's attention to the local environment and its peculiarities.

The teacher's attention is drawn to the fact that in the first three books, topics and sub-topics have not been clustered together except at the beginning and in a few essential instances. This has been done to help avoid monotony and topic-grinding. The teacher is, however, free to follow a topic order in teaching if this is found preferable. In the books, the material is graded in order of comprehension difficulty and topics dovetail in a logical sequence.

In writing the books, every attempt has been made to appreciate the possibilities and limitations of the classroom situation. The authors, who are practising teachers themselves, are grateful to the many teachers consulted in the preparation of the books from whom they received comments, encouragement and advice. They are likewise grateful to the artists whose illustrations have brought these ideas alive.

M. VINCENT SIMON
JULIA FRANCIS

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1 THE MOON, THE SUN AND LIGHT

Many hundreds of years ago, men believed that the Sun revolved round the Earth. It was thought that the Earth was the centre of the whole universe. An astronomer called Copernicus was one of the first people to declare that this was not so. Later, in 1613, Galileo Galilei made a dramatic announcement of his discovery—it was the Sun which was the centre of the Universe, and the Earth went round it.

We have learnt in the earlier books about the solar system and the Earth's own place in it. The Earth is a planet. It spins on its axis once every 24 hours and this makes our days and our nights. As it spins on its axis, the Earth also orbits round the Sun once every 365½ days.

THE MOON

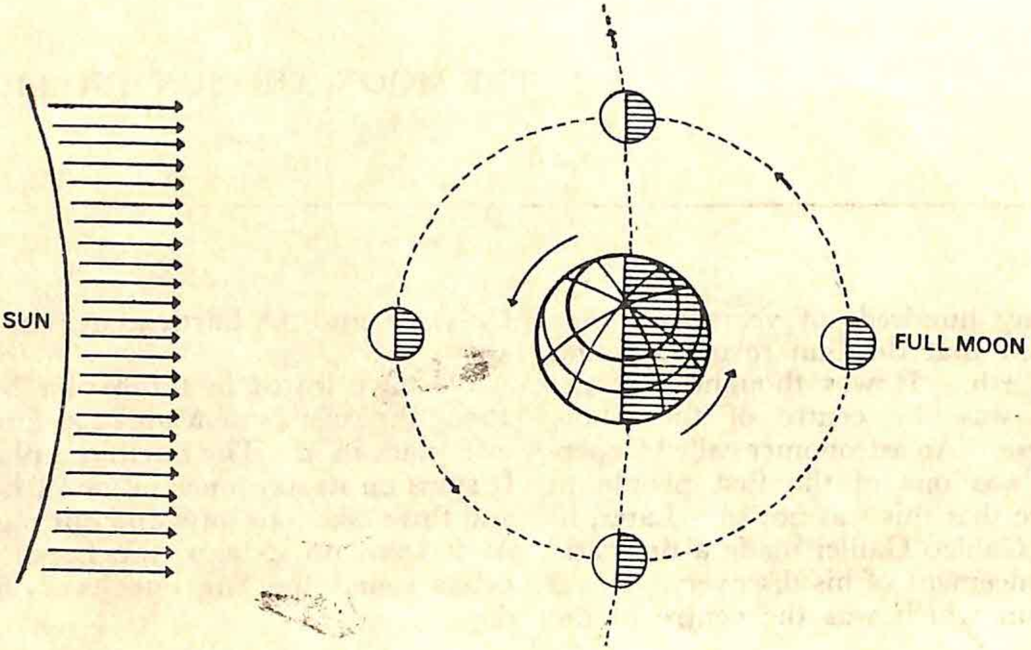
Many of the planets in the solar system have their own 'circle' of bodies revolving round them. These bodies are called satellites. The moon is a natural satellite of the Earth, and it is the only satellite the Earth has. The planet Jupiter has as many as twelve satellites, and Saturn has nine.

The picture on page 3 shows you other kinds of satellites. They are made by men. They are put into space by space rockets. We have weather satellites, communication satellites and scientific satellites.

The moon orbits round the Earth once in about 27½ days. The interval from one full moon to the next, or from one new moon to another, is two days longer. It is at a distance of 400,000 kilometres from the Earth and has a diameter of 3500 kilometres.

The moon has no light of its own. Like all planets it reflects light from the Sun. As the moon revolves round the moving Earth, the half facing the Sun is fully lit. We see this fully-lit part only when it is *full moon*. The diagram on page 2 explains how this happens.

At a certain stage in their movements, the moon comes between the Sun and



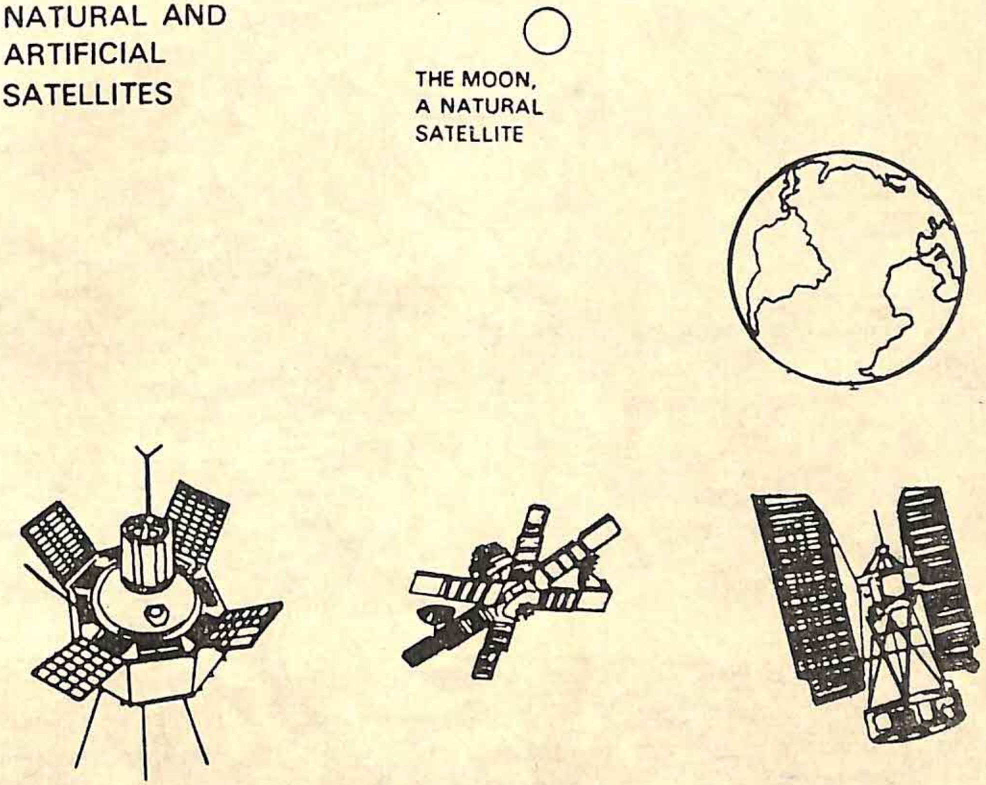
the Earth. At this point, the Sun shines fully on the half facing it, and the side we see is only a faint crescent of light. This is the *new moon.* The moon now changes gradually from new to full moon, and this takes about 14 days. It then starts to wane or grow smaller and at the end of 14 days, it is a faint crescent. These changing shapes of the moon are called phases of the moon.

The moon has been described in very beautiful terms by poets and singers. Actually, it is a dry, barren, airless satellite. It is because it is airless that we can see it so clearly, there is no atmospheric 'fuzz' round it to make it seem different from what it is.

On page 4 is a picture of the moon as seen through a powerful telescope. It is a satellite made up of rocky surfaces, towering mountains and craters. Many of these craters are believed to have been caused by meteors crashing down on the moon's surface millions of years ago.

If you look at the full moon you can see its irregular surface made of dark and light patches. Most of these dark patches are the moon's 'seas', the wide spaces between and around the mountains. They have beautiful names like the Sea of Serenity, the Sea of Nectar, the Sea of Showers and the Ocean of Storms. None of these oceans and seas, of course, have water. Some of the moon's craters are very large. One of these is Clavius, near the moon's

NATURAL AND ARTIFICIAL SATELLITES



THE MOON, A NATURAL SATELLITE

A SCIENTIFIC SATELLITE

A COMMUNICATION SATELLITE

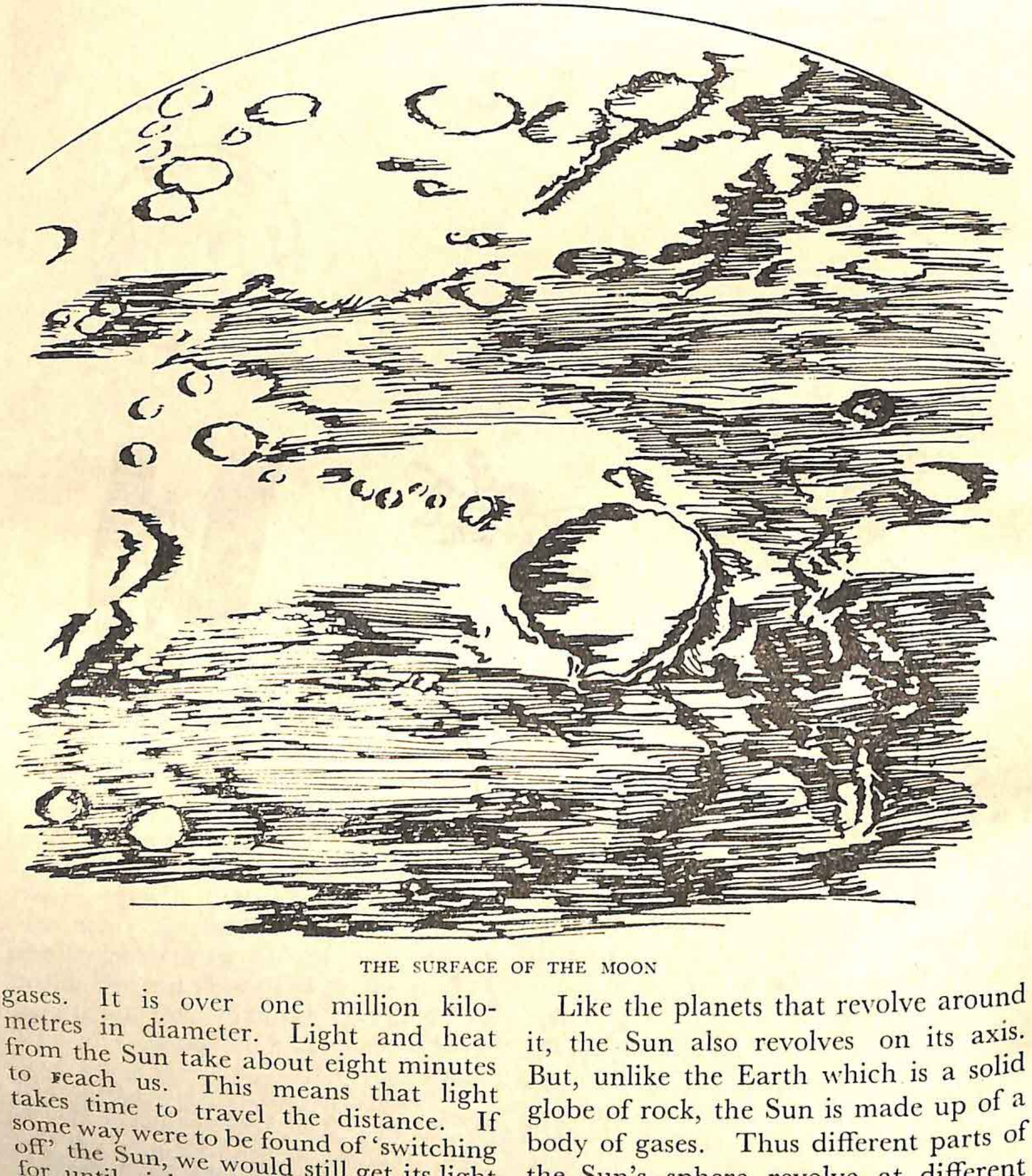
A WEATHER SATELLITE

southern pole. Another large crater has been named after Copernicus.

July 21 1969 was an exciting day for people on Earth. Two American astronauts landed on the moon—Neil Armstrong and Edwin Aldrin. Armstrong was the first man on the moon. The astronauts took pictures, brought samples of material from the moon. What they said about the moon confirmed what astronomers had always known when they looked through their telescopes—that the moon is a rocky globe with no life of any kind on it. Some of the rocks they brought back are similar to the rocks we find on Earth.

THE SUN

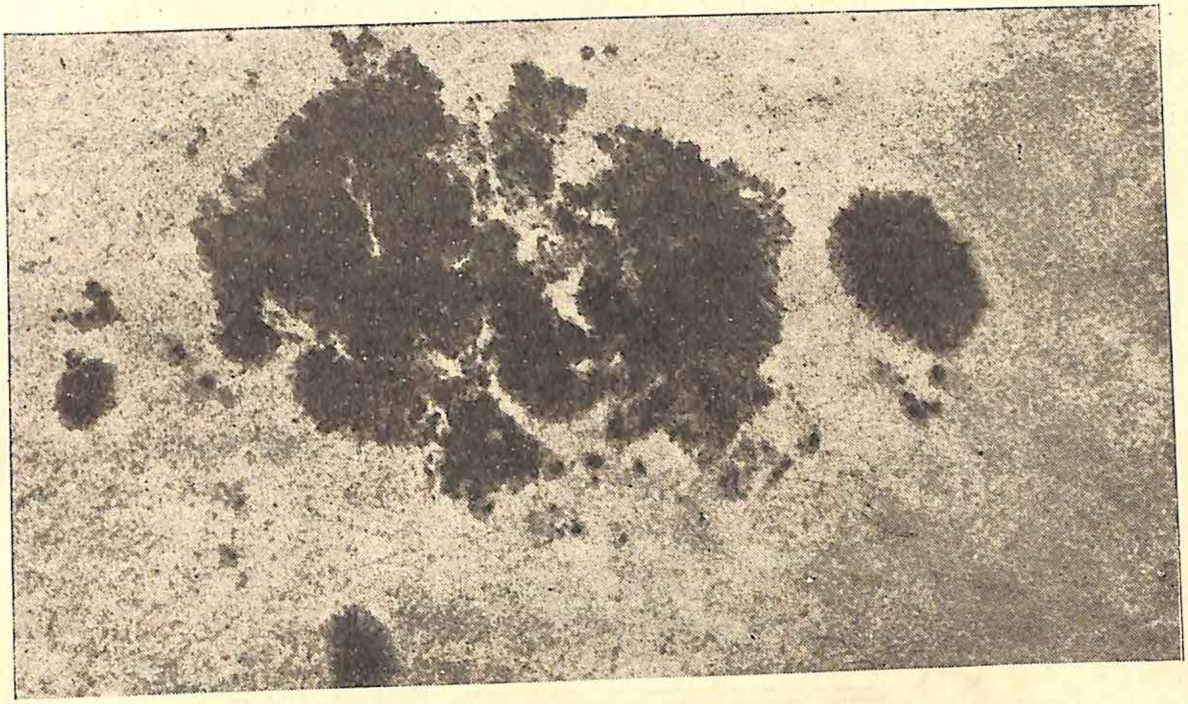
The Sun is our nearest star, and it is the centre of our solar system. Like the other, more distant stars in the sky, the Sun is a vast globe of glowing



THE SURFACE OF THE MOON

gases. It is over one million kilometres in diameter. Light and heat from the Sun take about eight minutes to reach us. This means that light takes time to travel the distance. If some way were to be found of 'switching off' the Sun, we would still get its light for until eight minutes.

Like the planets that revolve around it, the Sun also revolves on its axis. But, unlike the Earth which is a solid globe of rock, the Sun is made up of a body of gases. Thus different parts of the Sun's sphere revolve at different speeds. It takes the Sun between 25



and 30 days to make one complete rotation on its axis.

The Sun gives us light. It is unsafe to look at it directly because some of its rays might harm our eyes. It can be observed safely through a piece of dark glass, or even better, through a special reflecting telescope. If you look at the Sun like this you can see dark sunspots on its surface. Some of these sunspots are very large. They have a dark spot in the centre, surrounded by a border of light. The dark portion is called the *umbra* and the lighted border is the *penumbra*. The penumbra portions are less hot than the umbra portions but only in comparison.

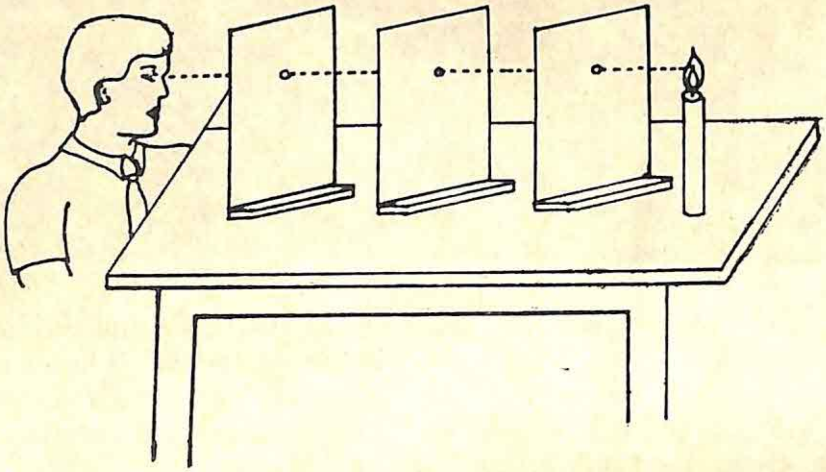
Hundreds of years ago, it was believed that the Sun burnt like a fire, that is, it used some fuel to burn. If this were so, the Sun would have burnt itself out long ago. The chief gas that keeps it alight is a gas called hydrogen. Scientists believe that there is enough hydrogen to keep the Sun 'lit' for another 8000 million years!

HOW LIGHT TRAVELS

Before we read on about eclipses, let us find out about light and how it travels.

Light travels in straight lines, and it is the fastest of all things. Its speed is 300,000 kilometres a second. Light is sent out by atoms. Different substances give out light in different colours. This is because they are made of different atoms.

You can try a simple experiment to see how light travels in straight lines. Take three pieces of cardboard. Place them one on top of the other and make a hole in the centre through them. Now mount them as shown in the picture. Place a candle as shown there and look through the hole of the cardboard near you. Adjust the cardboards in front until you can see the candle flame through. This is a straight line now, and you can see the flame of the candle because the flame and the cardboard holes are in a straight line. Now if you move one of the cardboards even slightly, you will not be able to see the flame.



Switch on a flashlight in a dark room. You can see the light from the torch going out in a beam. Watch the sunlight coming through holes in a roof or window. You can see it coming in a straight beam. Watch light as it is thrown from the headlights of a car or bus.

SHADOWS

Stand in sunlight and look at your shadow. Look at the shadow made by an electric lamp. Study different kinds of shadows. How are these shadows formed?

A shadow is formed when there is an object in front of a bright light. Shadows are cast by objects because they stop the light from going further.

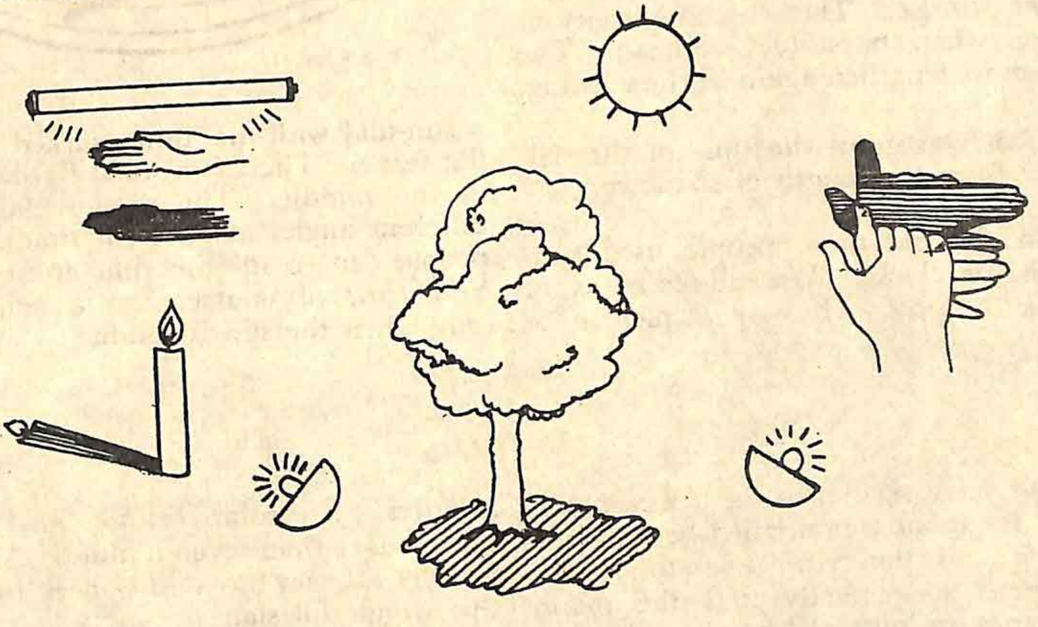
Two kinds of shadows

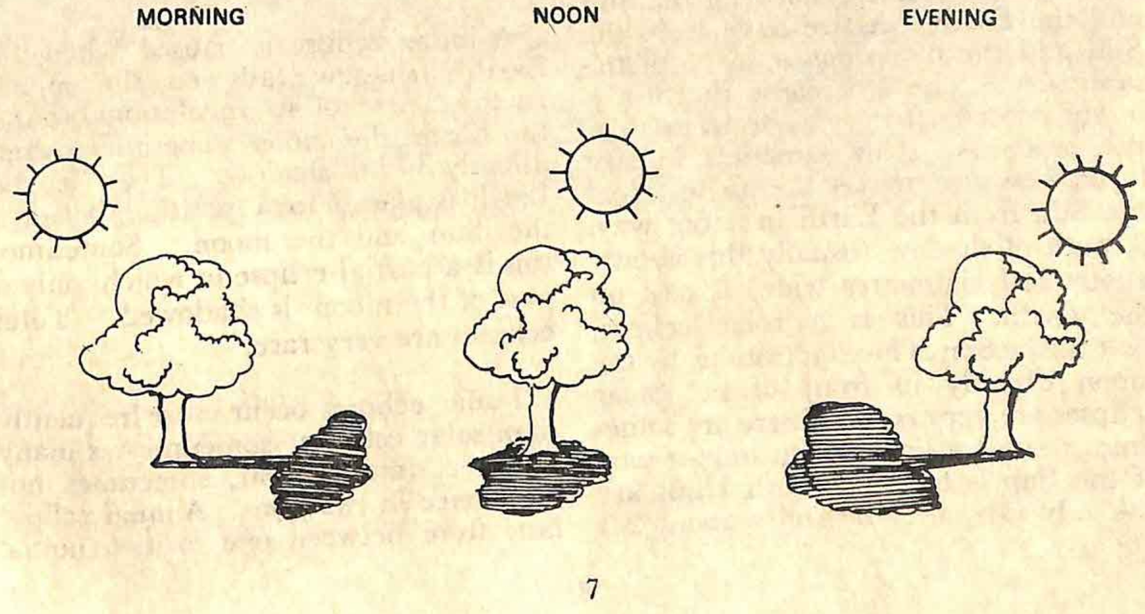
Stretch your palm under a tubelight. You may not get a 'faithful' shadow. This is because the source of light is large.

When an object is at a distance from a large source of light, two kinds of shadows are possible—a smaller darker shadow, and a fainter bordering shadow. We saw how in the case of the sunspot these are called umbra and penumbra.

Telling the time

Before watches and clocks were invented, people told the time from

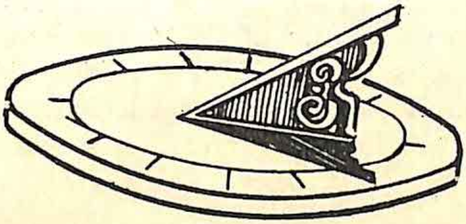




looking at the shadows made by the Sun on objects like trees and posts. On page 7 is a picture to show you the shadows cast by a tree at different times of the day. The shadows are long in the early hours of the morning, just after sunrise. They become short at noon when the sun is overhead. The shadows lengthen again in the evening.

Can you guess the time of the day now from the length of shadows?

In the old days, people used sun-dials for clocks. We still see many of these around. Here is a picture of a sun-dial with the time marked on a flat stone. There is a small fixed stone in the middle. The shadow falls at different angles at different times, and people can 'read' the time from this. You can, of course, use a sun-dial only when the sun is shining.

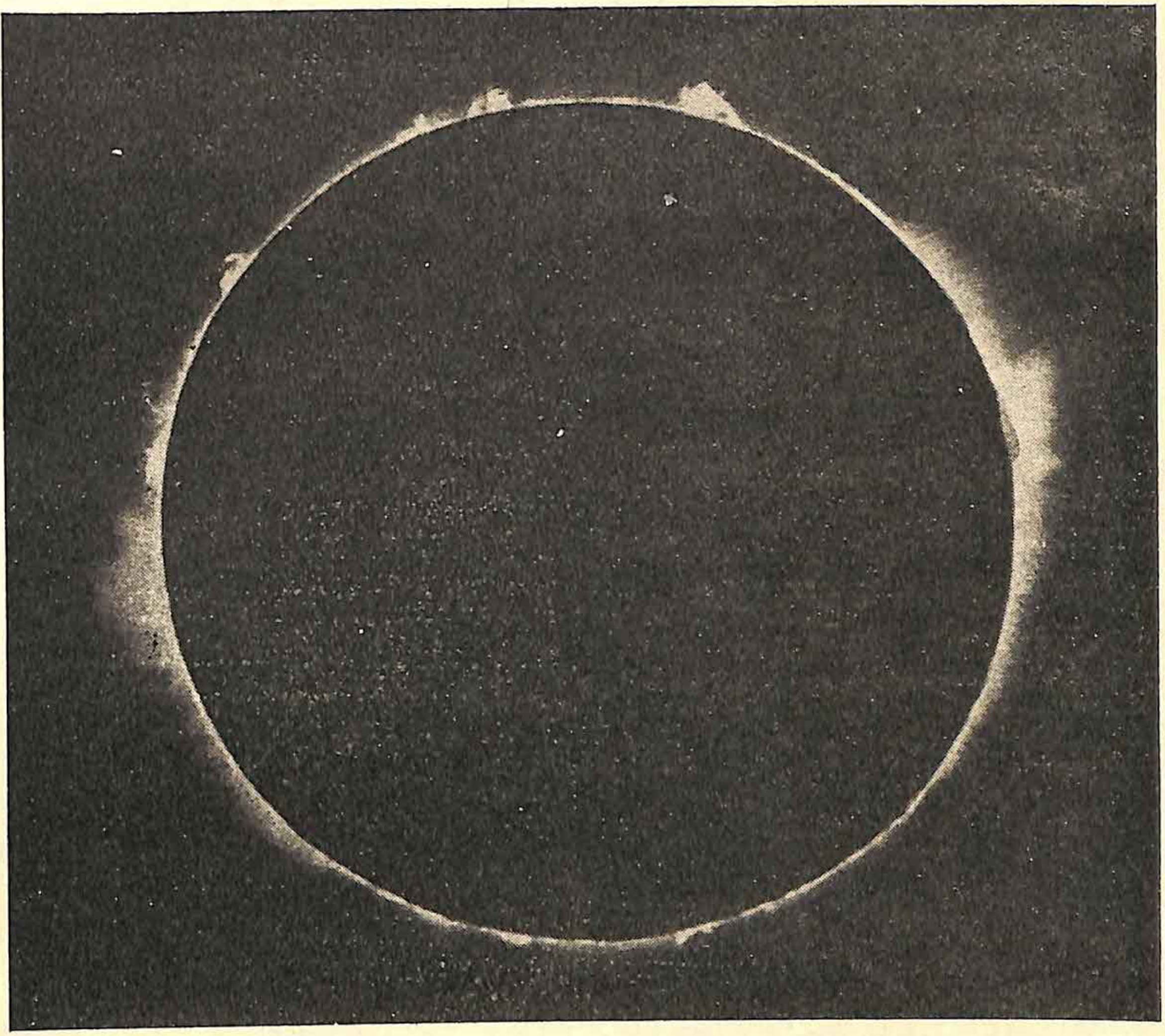


ECLIPSES

We have seen how on a new-moon day, the moon is positioned between the Earth and the Sun. Sometimes this happens so perfectly that the moon becomes an 'obstacle' between the Sun and the Earth. As we have seen, the Sun and the moon *appear* to be of the same size. This is because the Sun is many times further away from us than the moon is. This sameness in size to us, however, makes the moon shield the Sun from the Earth in a big way. A path of shadow (usually this is only about 300 kilometres wide) is cast on the Earth. This is a solar eclipse, that is, the Sun is hidden from us by the moon directly in front of it. Solar eclipses are very rare. There are sometimes partial eclipses when only a part of the Sun is hidden. Both kinds are not only rare, they last only about 2-3 minutes. No solar eclipse has ever been longer than seven minutes. Astronomers journey great distances to see this wonderful sight.

A lunar eclipse is caused when the Earth's shadow falls on the moon. In the course of its revolutions round the Earth, the moon sometimes comes directly in its shadow. That is, the Earth is placed in a position between the Sun and the moon. Sometimes this is a partial eclipse in which only a part of the moon is shadowed. Total eclipses are very rare.

Lunar eclipses occur more frequently than solar eclipses, sometimes as many as three times a year, sometimes not even once in two years. A lunar eclipse lasts from between one to two hours.



A TOTAL SOLAR ECLIPSE

Astronomers are able to predict exactly when it will occur to the nearest second, and they can also tell you where in the world it can be seen best from.

1 What is a satellite? Why is the moon called a natural satellite of the Earth?

2 What purpose do you think a weather satellite serves?

3 Explain what is meant by 'new moon' and 'full moon'.

4 What kind of surface does the moon have? What kind of planet is it?

5 What is the Sun and what is it made up of?

6 Does the Sun revolve on its axis?

7 What is meant by umbra and penumbra?

8 How does light travel and what is its speed?

9 What are solar and lunar eclipses?

10 Fill in the blanks:

a) The moon takes——————days to go once round the earth.
b) The moon is a————— of the earth.
c) A ————— is a body orbiting round a planet.
d) There are ————— ————— and flat plains on the moon.
e) ————— are cast when light is stopped by objects.
f) A solar eclipse occurs when the ————— comes between the ————— and the Sun.

1 Find out:

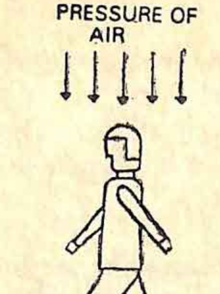
a) In a solar eclipse, how can the Sun be hidden by the moon when it is so much smaller than the Sun?
b) Why was the Skylab satellite launched into space?

2 Draw diagrams to show solar and lunar eclipses.

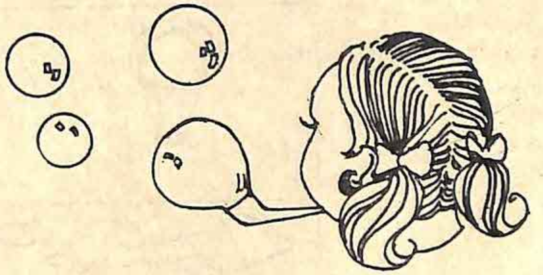
2 PRESSURE

Get a football to class. Pump air into it. As it fills it will push out and become round. Hold the air-mouth to prevent the air from coming out. Now press the ball. It is not very hard and you can press it down. Now pump more air into it until it is full and round. The ball will now feel hard and you cannot press it down easily. The football is now full of air and the air is pushing out and trying to escape. It is pressing outward —it has pressure.

Air is all around us and it exerts the force of pressure on everything. The force of gravity, which we learnt about earlier, pulls the air towards the Earth, and this causes it to exert a greater pressure than it would otherwise have.



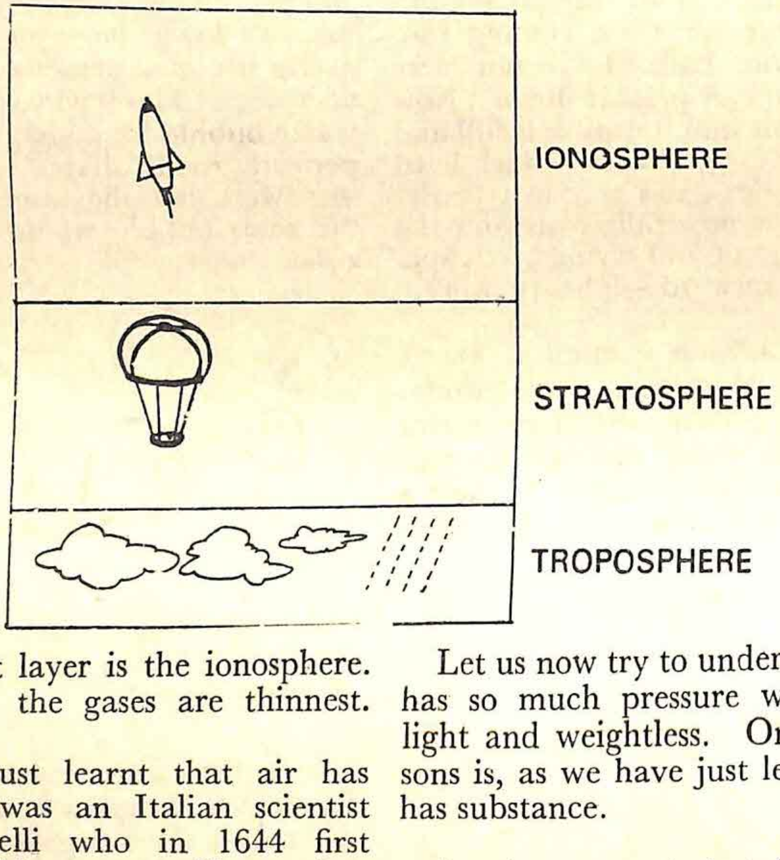
Air, as we know, has no shape. Because of this, it flows freely everywhere, filling up empty spaces. It presses down on everything and it exerts the *same* pressure on all sides of an object. This is why when you blow a water bubble from soap-water, it has a perfectly round shape. If the air pressure were not the same at all points, the soap bubble would have an irregular shape.



Air has weight because, like liquids and solids, it has atoms and molecules of many gases.

Scientists who have studied air have found that the great body of air around us, called the *atmosphere*, is about 400 kilometres thick around the Earth. This means that if you wanted to go into outer space which is airless, you would have to fly out above 400 kilometres.

The atmosphere consists of mainly three layers. The nearest to us is the troposphere which makes our weather and climate what it is. The layer above the troposphere is the stratosphere. It consists of very thinned-out gases, and rises to about 50 kilometres. The stratosphere has a layer of ozone, a gas-like oxygen. The ozone has a quality of protecting the Earth from harmful effects of sunlight.



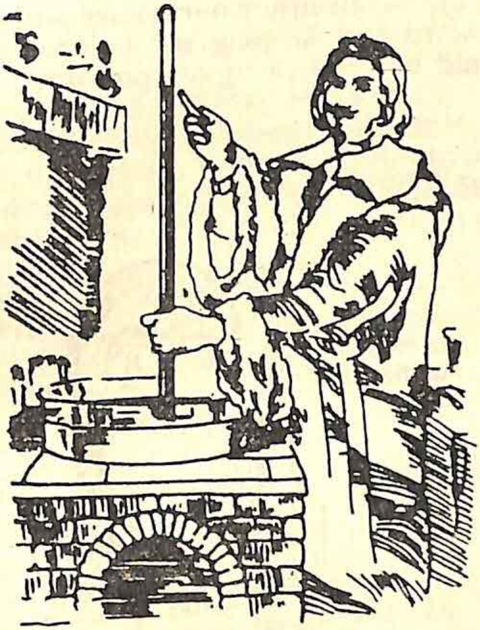
The highest layer is the ionosphere. At this point the gases are thinnest.

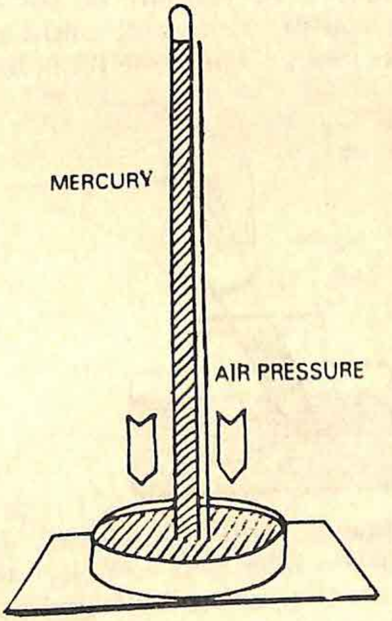
We have just learnt that air has pressure. It was an Italian scientist called Torricelli who in 1644 first showed that this was so. He conducted a simple experiment. He took a glass tube and sealed one end of it. He filled it with a substance called mercury. He then turned it upside down and placed its open end downwards in a small dish of mercury.

Now mercury is a heavy substance, and it ought to have run out of the tube. But it did not. It fell a little, but that was all. The mercury in the glass tube stood supported by the sheer force of the air pressure all around it. You can try the same experiment with water.

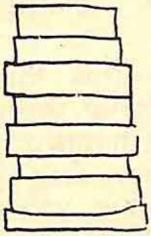
Let us now try to understand why air has so much pressure when it seems light and weightless. One of the reasons is, as we have just learnt, that air has substance.

Another reason is that the layers of air above the troposphere (i.e., the layer nearest to us) press down heavily on the troposphere. You will understand this better in a simple experiment with

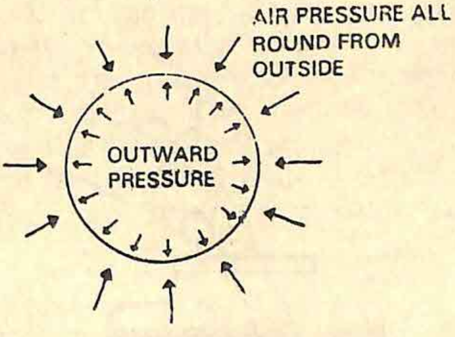




sponges. Take about eight sponges. Let them absorb water so that they have weight. Now pile the sponges one on top of the other as shown in the picture. You will see that the sponge at the bottom is pressed down flatter than the rest. This is because it has to support the weight of *all* the sponges above it. The pressure of the weight flattens the sponge.



Air is like this. Like the sponges, it is elastic, and when the air layers above it press on it, it presses in turn in all directions—upwards, downwards as well as sideways.



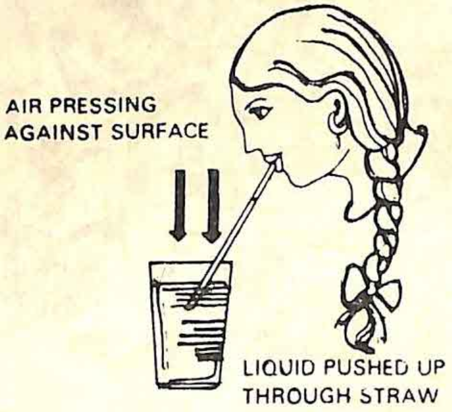
The wonderful fact about air pressure is that the upward and downward pressure of air is very strong. The football keeps its shape because of the pushing-outward pressure. If this were not there, the ball would collapse as soon as you filled it.

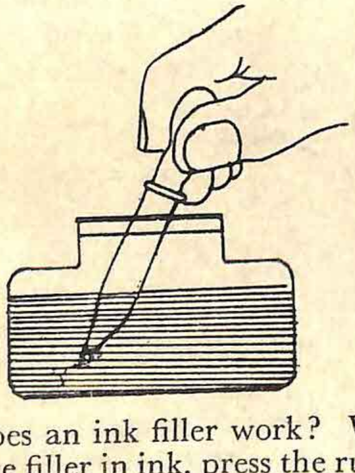
Did you know that air exerts a pressure of about 17,000 kilograms on every full-grown person? If it were not for the air inside our bodies pushing outward and keeping the balance, we would be crushed by air pressure.

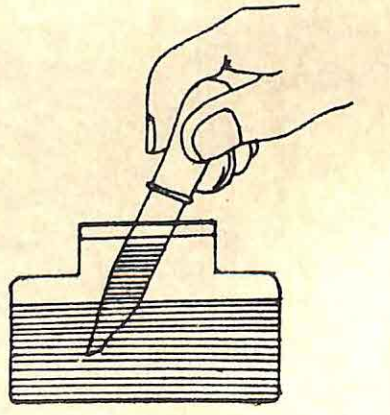
AIR PRESSURE ON LIQUIDS

Like on everything else, air exerts a pressure on liquids. There is a simple activity to help you understand air-pressure in an outward direction.

When you drink through a straw, the liquid rises up through the straw. How does this happen? What is happening is that when you suck air through the straw, you take away the air that presses against one part of the liquid. The air pressing on other parts of the liquid now push the air in that direction. As you go on sucking, the air pressing on the liquid goes on making the liquid move up through the straw.







How does an ink filler work? When you dip the filler in ink, press the rubber bulb and release it, the ink slowly rises through the glass tube. This happens because the air surrounding the filler exerts pressure on the liquid. When you press the bulb and let it go, it sucks in air. The same thing happens as happened with the straw. In the case of the filler you can 'see' the air filling up the rubber bulb and pushing it back to its actual shape.

1 What qualities does air have? (Hints: weight, elastic, filling up empty spaces, pressing downwards, sideways, upwards and outwards etc.)

2 What is atmosphere? Describe the layers of air in the atmosphere.

3 Explain Torricelli's experiment. Why did the tube of mercury stand up?

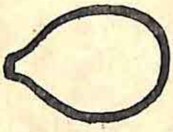
4 Explain what happens when you drink liquid through a straw.

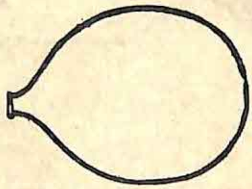
5 Look at the pictures on page 16. Describe each experiment and why things happen as shown.

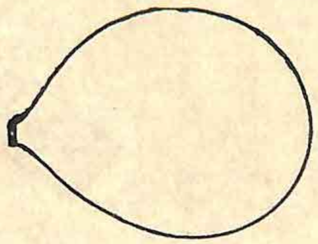
AIR PRESSURE AND BALANCE

When you pump air into a cycle tyre and close the valve, the air is sealed in the tube which is like a rubber bag. It cannot escape, so it pushes outwards. If the tyre is full of air, the pressure of the air inside can resist the pressure of air outside. At this point the air inside has the maximum or the fullest pressure. The walls of the tube are strong, so the tyre will not easily burst.

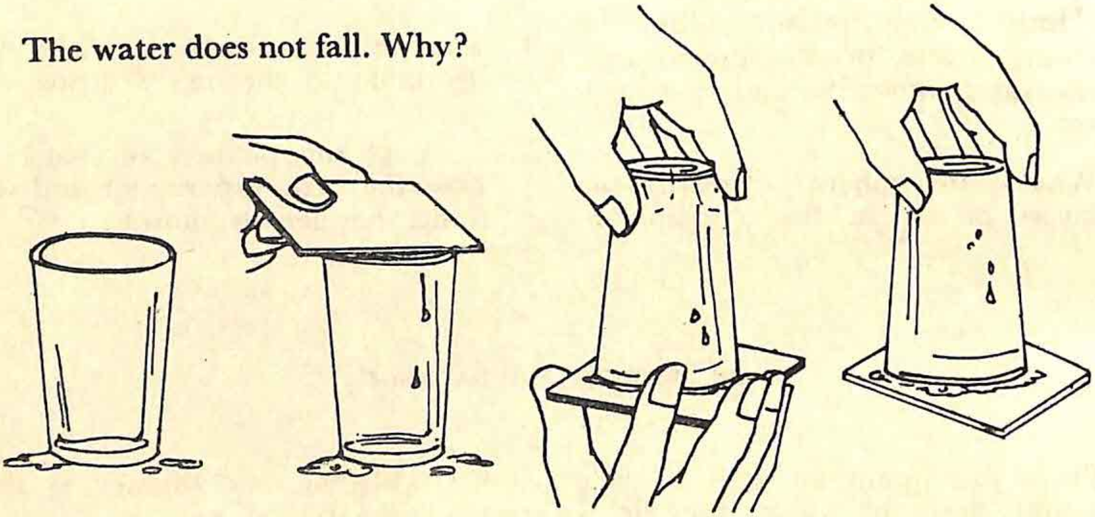
But look what happens when you blow into a balloon. The balloon swells in size as the air fills it. The rubber walls become thinner as they stretch. Finally, if you continue to blow in air, the balloon will burst. This happens because the pressure becomes greater and greater inside the balloon when it is filled to the maximum, (that is, it cannot stretch any more to take in more air) it can no longer withstand the pushing-out pressure of the air inside. The balloon bursts because this pressure is strong and also because the pressure inside the balloon is *stronger* now than the pressure outside.

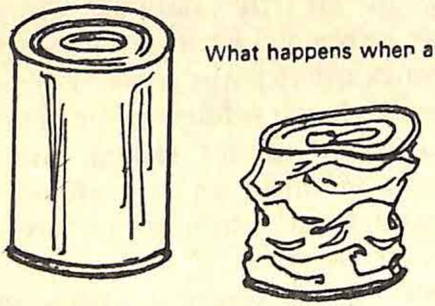






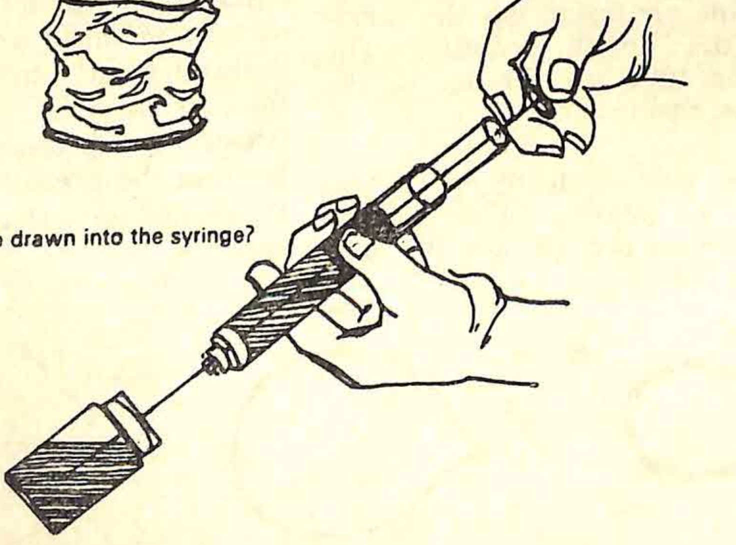
The water does not fall. Why?





What happens when air is pumped out of this metal can?

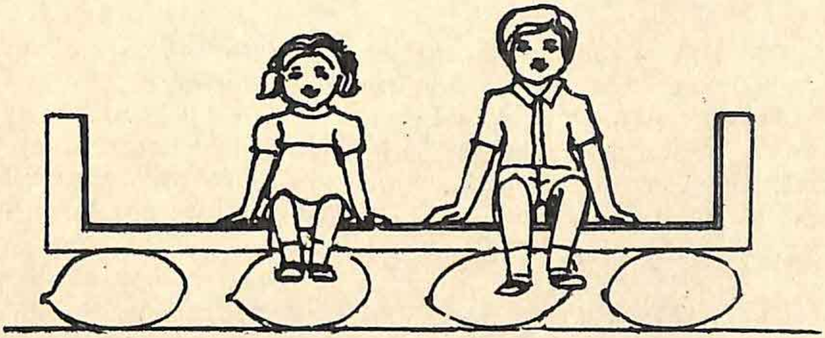
How is the medicine drawn into the syringe?



In any air-filled object, the pressures balance until some force increases the force of one of the pressures. If you take a tin and pump the air out of it, it will collapse as shown in the picture. This is because the air pressure outside is greater.

Here is an interesting experiment with air pressure. Blow air into about ten medium-sized round balloons of the same size. Tie up the mouths tightly so that no air escapes. Take care to see that the balloons are not filled too tightly.

Now place the balloons on a clean, smooth floor. Invert a light table over the balloons as shown in the picture. Ask two children in your class to sit on the flat board of the table. You will find that the balloons can support their weight. The pressure inside the balloons can withstand the pressure of the children's weight.



1 Find out:

a) When you ride a tricycle on a rough road you can feel the bumps but we do not feel them so much when riding a bicycle. Why is this so? Remember that a bicycle has air-filled tyres, and a tricycle has solid rubber tyres.

b) Why does a car tyre need greater pressure of air than a cycle tyre?

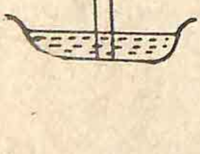
c) Why does an almost full-blown balloon get back to its round shape after you have flattened it by pressing it between your palms?

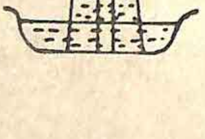
Air, as we know, is everywhere. It is a mixture of many gases. Three of these are present in the air in greater quantities than the rest—these are *nitrogen*, *oxygen* and *carbon-dioxide*. Without air and these important gases in it we would not be able to survive. All living things would die. The moon is airless, that is why spacemen had to take oxygen cylinders with them when they landed on the moon. Let us look more closely at oxygen, one of the most important to us of the three gases.

Oxygen

About one-fifth of the air around us is made up of oxygen. Oxygen is necessary for our life and for the life of other living things. When mountaineers scale mountains, the air gets thinner, and mountaineers have to carry oxygen cylinders to keep the balance of air.

One of the most important qualities of oxygen is that it is used to make things burn. You can find out more about this by trying a simple experiment. Take a dish. Fix a candle to it by lodging the candle in the wax dripping off the candle. Now pour water into the dish. Light the candle carefully. Invert a glass or a milk bottle over the candle and watch.





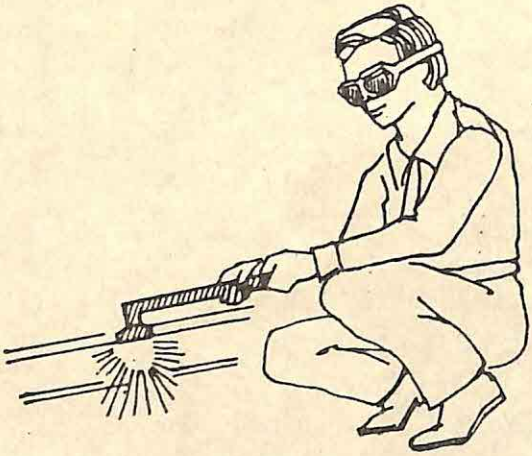
After a while you will see that the candle flame burns uncertainly and finally it goes out altogether. While it is still burning, something else is happening. The water in the dish is rising into the bottle. By the time the candle has burnt out, a good bit of the water has risen into the bottle.

Now let us see how this happens. The candle flame was kept alight by the oxygen. As it burnt, the flame used up the oxygen in the bottle until there was none left. At this point the candle went out. Now air from the dish moved in to take the place of the oxygen. It exerted pressure on water and caused it to move into the bottle. The water cannot fill up the bottle further because there are *other* gases in the bottle. Most of this is nitrogen which does not help burning.

You can try another experiment in the classroom to show how oxygen helps things burn. 'Make' oxygen in a bottle by putting a little hydrogen peroxide and a pinch of potassium permanganate in the bottle. You will see bubbles coming from this mixture and oxygen is being made. Now if you plunge in a glowing splinter of wood, you can see it burst into flame.

Oxygen has been of wonderful use to man. It can be separated from the air and stored in strong cylinders. It can be stored as a liquid at very low temperature. It is used to burn a gas called acetylene. When acetylene

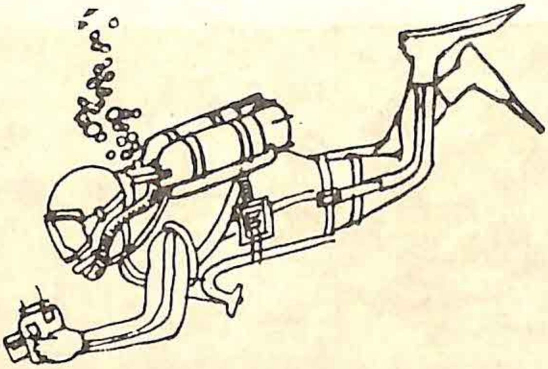
TENSING AND HILLARY CLIMBING MOUNT EVEREST burns with oxygen it produces a very hot flame and can be used to cut iron or steel or to join pieces of metal. It is called an oxy-acetylene flame. Here is a man using an oxy-acetylene flame.



Oxygen is very important in our world. Without its help nothing can burn. Fuels cannot burn without oxygen.

On page 19 is a picture of Tensing Norgay and Sir Edmund Hillary. They climbed the top of Mount Everest in the Himalayas, the highest peak in the world. The air there must have been very thin and they had to take oxygen with them to help them breathe.

Look at this man. He is a deep-sea diver. He, too, needs oxygen when he is under water and he carries it with him. Fish can live under water, breathe in the oxygen dissolved in the water, through their gills.



Here is an experiment tried out by someone. A man boiled water in a saucepan. He then cooled the water. When it had cooled completely, he put a fish into it from the fish-tank. The fish swam around, then it swam more slowly. Finally it seemed hardly alive. The man lifted the fish and put it back into the fish-tank. The fish now started to swim slowly. Can you explain what happened?

Carbon-dioxide

There is another well-known gas called carbon dioxide. It is found in very small quantities in the air. We get carbon dioxide by burning many things.

Every time we breathe out, we breathe out carbon dioxide.

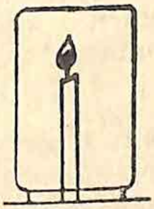
Let us see some of the qualities of carbon-dioxide. Take a little lime water in a clean dish. Let it be open to the air. Observe the liquid the next day. Is there any change? You can see a whitish substance on the surface of the water. How did it get there?

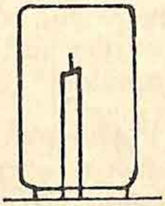
When carbon dioxide comes in contact with lime water, a whitish substance is formed. In this case, the carbon dioxide could come into contact with only the surface of the liquid.

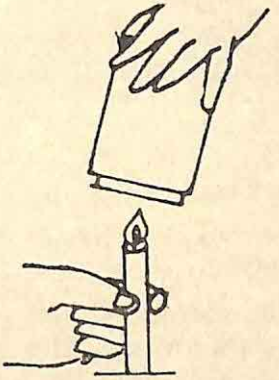
Now pour the liquid into a glass. Breathe into it through a straw. You will see that the liquid turns milky.

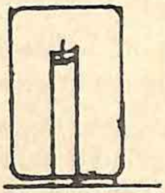
Carbon dioxide mixes with some substances and changes their form or colour. It also puts *out* burning flames. In burning, oxygen and carbon-dioxide act one against the other.

Here is a simple experiment to understand this. Invert a jam jar over a burning candle. Presently, the flame will go out. Now light another candle. Lift the jam jar and plunge the burning candle into it. The flame goes out. How do you know it was carbon-dioxide that put it out?









Carbon dioxide is a heavy gas. You can try out another simple experiment to study this. Mix equal parts of vinegar and water and put them into a bottle with a one-hole stopper through which a tube leads out (see picture on top of page 22). Now take a little baking powder (sodium bicarbonate) and tie it in a muslin pouch. Open the bottle, put in the bag of soda and quickly cork it again. Soon you will see the contents of the bottle bubble. The mixture produces carbon dioxide which flows out through the tube. Now light a small candle, and hold it at the mouth of the tube. The flame will go out. (What would have happened if the gas coming out of the tube had been oxygen and not carbon-dioxide?)

Now balance two glasses or tins on a see-saw balance as shown in the picture. Make sure they balance equally. Now hold the tube in the experiment just described over one of the tins and let the carbon-dioxide flow into it. What happens? What does this tell you about the weight of carbon-dioxide?

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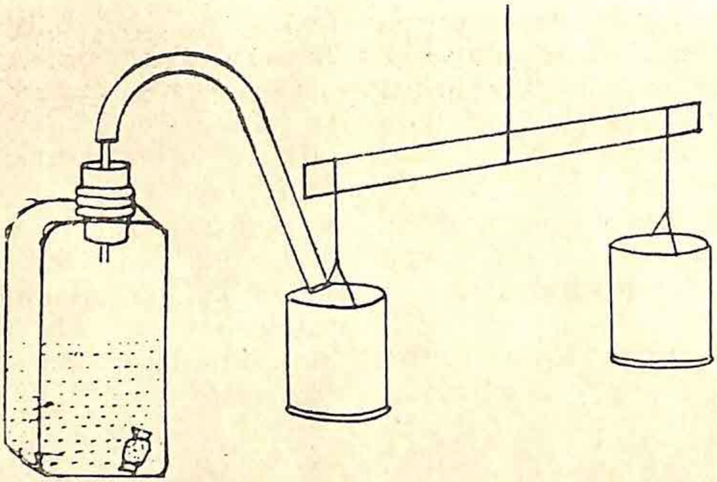
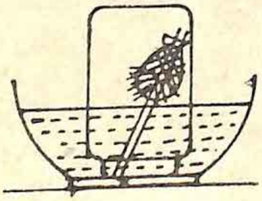


1 What are the gases found in the air?

2 What qualities does oxygen have? Describe experiments to show this.

3 In the experiment described on page 21, how do you know that the oxygen in the bottle was used up? What would you have needed to do to keep the flame alive before it went out?

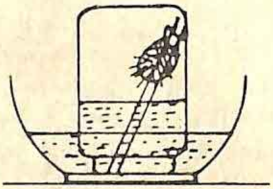


1

4 What qualities does carbon-dioxide have?

5 Suppose two jars, one containing oxygen and one containing carbon-dioxide were placed before you. You were not told which was which. What simple experiment would help you decide which contained oxygen and which contained carbon-dioxide?

6 If you place a glass of clear water over a warm surface and look at it again after a few hours, you will see tiny water bubbles in the water. Can you explain how they came to be there?



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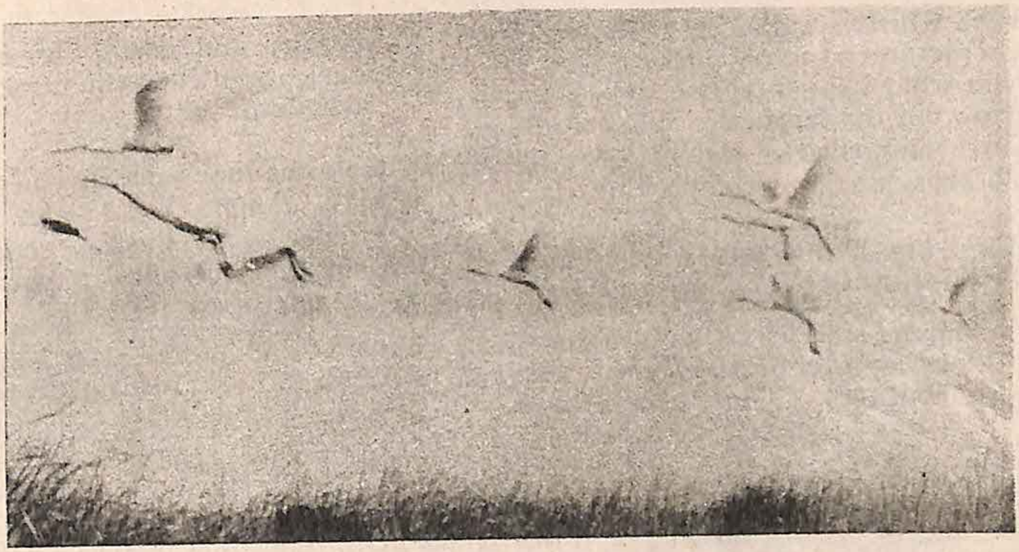
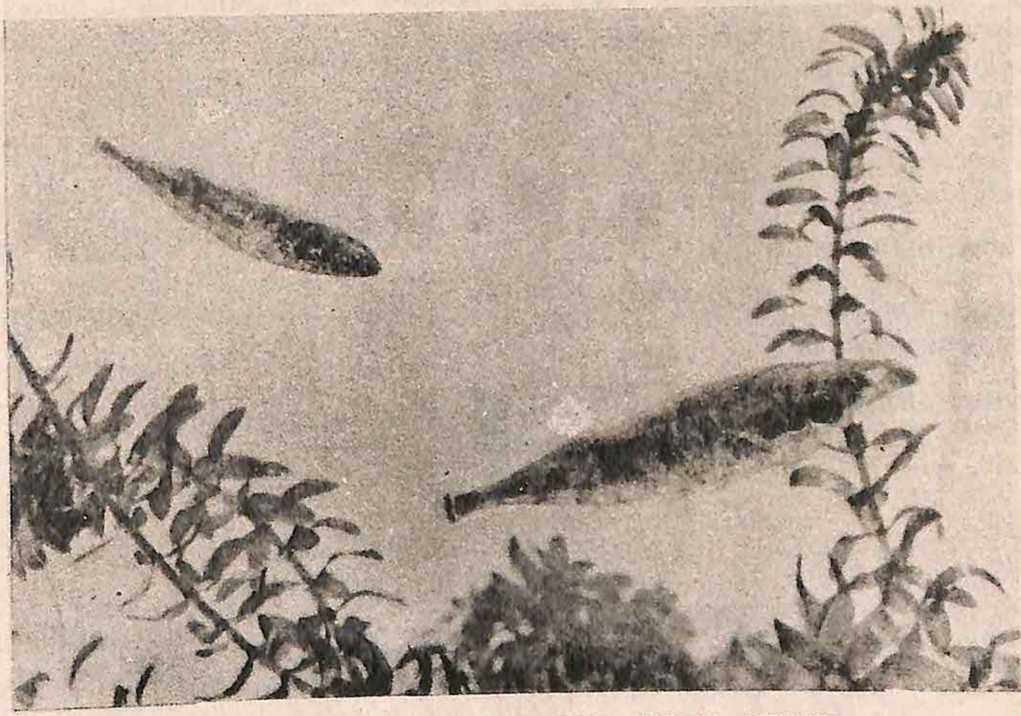
7 Here is an experiment:

A few cockroaches were captured live and tied in a piece of mosquito netting. The netting was tied to a





BIRDS, PLANTS AND FISH BREATHE IN OXYGEN stick which was placed as shown in the picture on page 22. Picture 2 shows you what happened two days later. How did this happen? What would have happened if you had left the cockroaches this way for a long time?

8 Find out if this statement is true or false:

> Baking soda mixes with water to form carbon-dioxide in the form of bubbles. The bubbles have pressure and rise. This is why a cake rises when you put baking soda in the batter.

9 Take some lime juice or vinegar in a glass. Pour a little water in it. Sprinkle some baking soda on the mixture. What do you see? What gas is it?

10 Look at the pictures on page 23. How do fish and birds get a regular supply of oxygen?

AIR POLLUTION

The air we breathe should be fresh. We try to make sure of this in many ways.

Unfortunately, not all of us breathe in fresh air all the time. Sometimes this is because of the places we live in. Factory chimneys give out smoke and other impurities which pollute the air. Jet aircraft flying low gives off unhealthy fumes. So do cars and other motor-driven vehicles. Coal-smoke is one of the most harmful impurities in the air.

Today, many factories which used to burn coal for fuel, are using other 'smokeless' fuels. They are using coke, gas or oil instead of coal.

Another impurity present in air is dust. We do not feel the presence of dust in the air, but it causes a lot of damage. People with lung troubles are sensitive to dust. Dust carries disease germs with it. This is why hospitals for the treatment of breathing ailments and diseases are situated in places away from the town where there is plenty of fresh air.

1 Find out why a miner's job is dangerous. In what ways can the air around him be unhealthy?

2 Why do factories have tall chimneys?

3 Why are scientists experimenting with smokeless fuels?

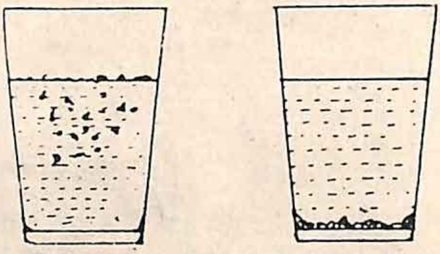
WATER AND DISSOLVING

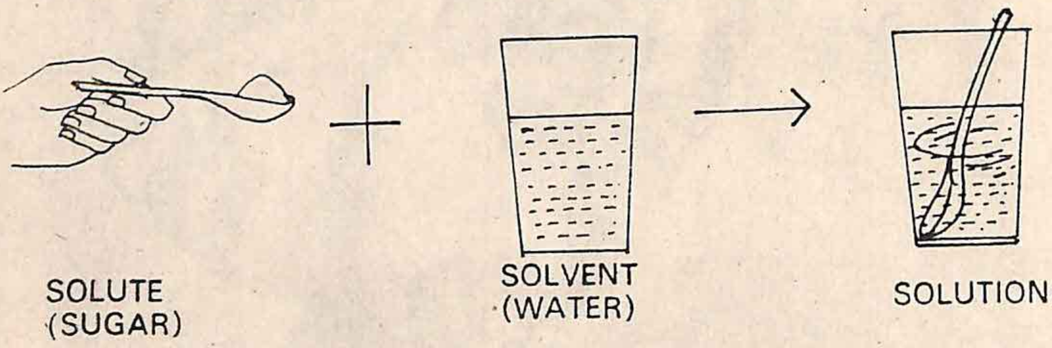
Put a small red ink tablet in a glass of water and stir it. The tablet dissolves in the water and after it has dissolved, you cannot easily separate the ink from

FLOATING IN AIR

the water. Now dissolve a teaspoon of sugar crystals in water. You now have a solution of sugar and water.

Water is a good dissolver—the word we use is *solvent*. Water is a liquid. Sugar is a solid. The sugar solution is a liquid. Sugar is a *solute*, the thing dissolved. Water is a solvent, the dissolver. The combination of solute and solvent results in a solution.





The solute can be separated from the solvent. The process is often elaborate and for some solutions you need to work in a laboratory to get accurate results. Sugar and water are fairly easy to separate.

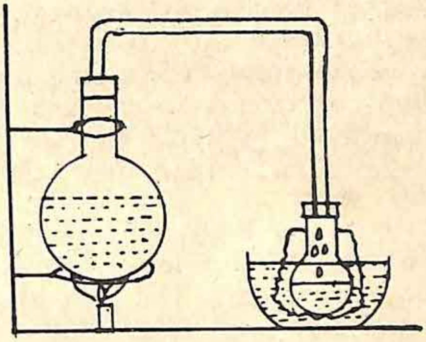
Take a fairly thick sugar solution. Keep it in a shallow glass dish in strong sunlight for a few hours. You can see the sugar crystals forming again in the solution. Try the same experiment with a solution of alum. What do you get when the solvent is evaporated by the sun?

DISTILLATION

Take a little salt water in a pan and cover it with a clean lid. Heat the water gently. After some time, remove the lid. You will find drops of water on the inside of the lid. This, as we know already, is water vapour condensed into water.

Now taste the water on the lid. Is it salty? You will find that it is not, because the solution has been distilled. The water drops or the distillate are the water got from the condensed water vapour. This is pure water and will not have the qualities of the solution from which it has been distilled. The salt molecules in the water do *not* rise into the air as water vapour.

Distillation is thus the best method of getting very pure water. We can see in this experiment how distillation can be done in a laboratory. The water is boiled in a glass flask and the steam is taken out in a tube. The steam is forced through the tube into a receiving flask which is kept in cold water and cooled further by a wet towel. (Why is this done?) You can actually see the vapour condensing into water.



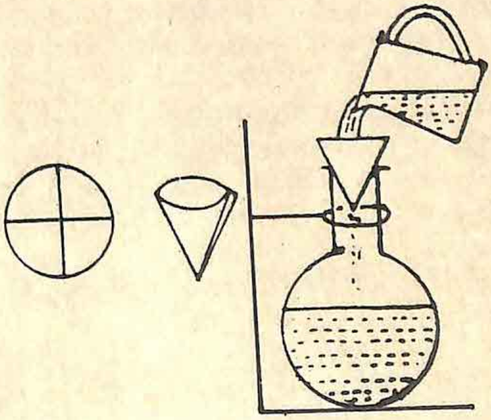
PURIFYING WATER

Many cities and towns get water from rivers. A river goes winding over land. As it flows it carries with it clay, sand, sticks, leaves, dead and live animals and other organic matter. If we have to use this water, it has to be purified, the harmful impurities have to be removed from it.

Get a glassful of muddy water. Place the glass on a table and leave it for a few hours. You will notice that all the floating matter settles down. These are called sediments. The process of their settling down is called sedimentation. You can decant water from the glass now without disturbing the solution.

Decanting is the process of pouring liquid into another container, leaving the sediments behind in the first container. When you pour tea from a tea-pot in which you have added boiled water to the tea-leaves, you are decanting tea. Ground coffee is also decanted in this way. The better way of removing suspended impurities is by filtration. Have you seen the filters and strainers used in your kitchen? The tea-strainer is made of fine nylon netting or of a metal sheet with holes in it. The liquid tea passes through the holes but the holes are too small for the leaves to pass through.

You can filter decanted rain water with the help of filter paper. The paper is folded as shown and placed in the funnel. The decanted water, which still contains some floating impurities will pass through the filter paper and come out crystal clear.



Another process of 'cleaning' water of the heavier impurities is sedimentation. Sedimentation is a long process. In many waterworks, a chemical called alum is used to make the sediments settle down faster than they otherwise would.

You can see this for yourself in a simple experiment. Get two glassfuls of water from a puddle. Put a little powdered alum in one of them and stir it. You can see the particles in this glass join together and settle down quickly. The water can now be carefully decanted.

Drinking water

The water that comes to our taps is filtered by the water-works but it is still not very safe to drink. The water may contain harmful bacteria and germs. These can be destroyed only by boiling the water. Diseases like cholera and typhoid fever may be carried in unboiled water.

Cholera is a disease that is spread through unclean food and water. It can be caught very easily if you swallow the bacteria. Sometimes hundreds of people are infected. Some kinds of cholera can even cause death. Typhoid fever is infectious. If the patient does not take sufficient care, he may be ill for the rest of his life, he may even die.

The municipal and the public works department of every city tries to ensure that every care is taken to avoid the spread of these diseases. The ponds, lakes and wells are treated with chemicals to destroy the bacteria. So are drains and gutters. Our tap water is treated with bleaching powder. Bleaching powder gives off a gas called chlorine which kills germs and the water is chlorinated. You can sometimes smell the chlorine in your water.

Another chemical used to clean water is potassium permanganate. The crystals of this chemical are dark in colour and when you put them in water, they dissolve and make a purple solution. We can wash fruits and vegetables in this water.

Water from the rain

As we have just learnt, rain water is pure, distilled water. It does not taste like ordinary water because there are no minerals in it.

Rain water is not as clean as it should be because as it falls through the air, it collects particles of smoke and dust. Usually, the best time to collect rain water is after the first shower.

You can collect rain water. Take a large, clean bottle. Place a clean funnel over it. The larger the funnel the more water you are likely to collect. Look at the water by holding it up to the light.

1 Name two of each of the following:

- *a*) impurities in the air
- *b*) diseases caused by floating germs
- *c*) crystals that dissolve in water
- *d*) suspended impurities in water
- *e*) materials that can be used for filtering.

2 Write a paragraph to describe these words:

decant distil filter chlorinate sedimentation

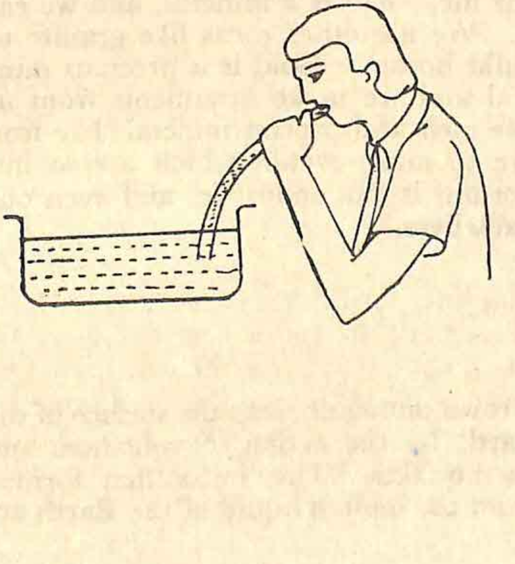
3 When you make salt water, which is the solute and which is the solvent?

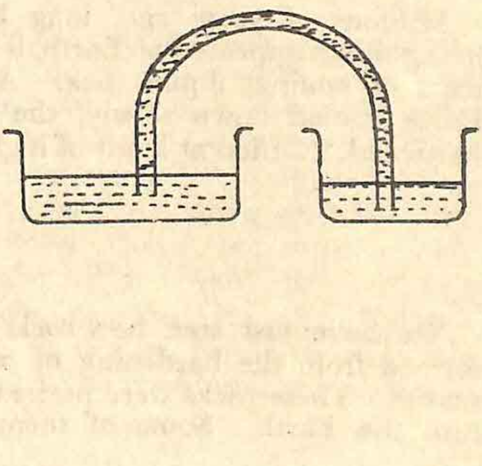
4 Here is an experiment. The water is being pumped out using a siphon. Explain how a siphon works.

5 Why do we have water plants in fish tanks?

6 Fill in the blanks:

- a) About one-fifth of the air around us is made up of a gas called ______
- b) Suspended impurities in water are removed by sedimentation and ______.
- c) ______ is mixed in water for quick sedimentation.
- d) ______ is used for chlorination of water.
- e) Rain water does not taste like ordinary water because there are no ______ in it.





3 THE EARTH'S ROCK AND MINERAL RESOURCES

The Earth is a storehouse of materials. For thousands of years, men have used these resources, mainly to make Earth a safer and more comfortable place to live in. These resources include water, the soil and the minerals of the Earth. Water must have been one of the first things men learnt to use, later the soil and the Earth's mineral resources. All these are the natural resources of the Earth.

Our world is rich in mineral resources. Like Earth other planets have their own minerals. The astronauts who landed on the moon found that several rocks contained minerals similar to those found on Earth.

Millions of years ago, long before living things appeared on Earth, it was a mass of boiling, liquid rock. As the Earth cooled down slowly, the rocks hardened. Different kinds of high and low rocks were formed. Over the years, weather conditions broke rocks into smaller pieces. Some of these later became a part of the soil of the Earth. Other rocks got pushed under the ground, some into the seas and oceans, others below the land. All these rocks cooled slowly and as they cooled, the substances inside them were formed. These substances are *minerals*. As time went by the minerals hardened, mixed with others and began to show distinct qualities of their own. Many of them developed beautiful crystals.

Minerals are a very important part of our life. Salt is a mineral, and we eat it. We use other rocks like granite to build houses. Gold is a precious mineral and we make ornaments from it. We melt and process minerals like iron ore to make metals which are so important in our industries and even our daily lives.

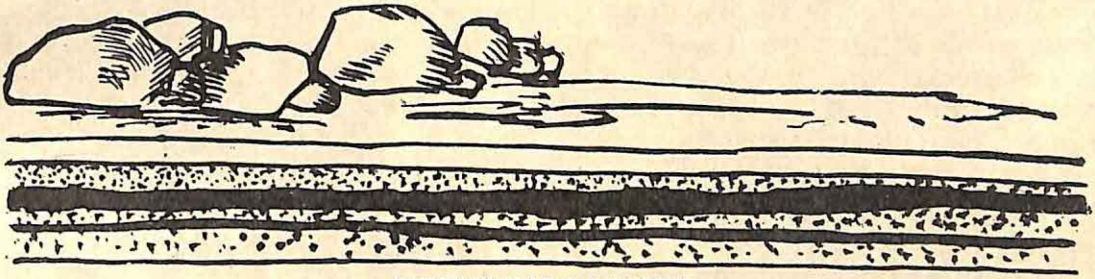
ROCKS

We have just seen how rocks were formed from the hardening of molten matter. These rocks were pushed deep into the Earth. Some of them were thrown out again onto the surface of the Earth by the action of volcanoes and earthquakes. The rocks first formed from the molten liquid of the Earth are called igneous rocks. 'Igneous' is a word which literally means 'made by fire'. We have many kinds of igneous rocks. Granite is one of these, basalt is another.

Rock forms take place in two ways.

A lot of mineral and soil matter is carried away when water flows down the mountainsides and over land to the sea. This matter gets deposited in the seas. Over millions of years, layers of this matter form sediments in the floor of the sea. By close contact and also by a chemical process, the layers harden to form rock. This kind of rock is *sedimentary rock*. Coal is a sedimentary rock.

The other kind of rock is *massive rock* or *metamorphic rock*. This rock changes under conditions of heat or pressure. Many kinds of massive rocks are really igneous rocks which have melted under great heat or pressure, and formed crystals again. Because of this, metamorphic rock does not have the layers you see in sedimentary rock. Marble, as you will learn, is a metamorphic rock.

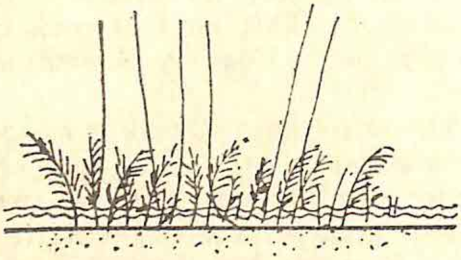


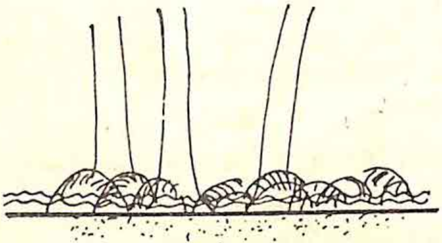
SEDIMENTARY LAYERS

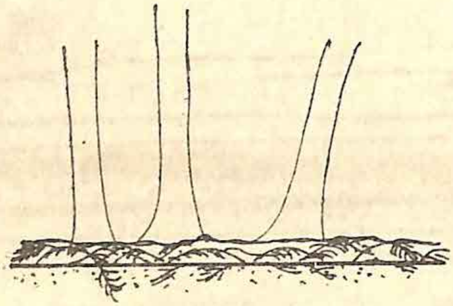
COAL

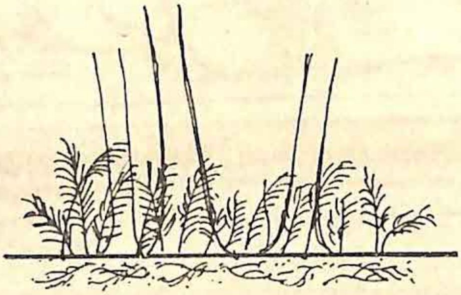
Did you know that coal is a rock that comes from decayed plants? It is found in some rocks and is often called a mineral rather than a rock for this reason.

More than two hundred million years ago, some regions of the earth were swamps. They were covered with water and huge ferns and other plants as high as trees grew in these swamps. As these plants died out, they sank to the bottom of the swampy water and decayed there deep in the Earth. They were gradually covered by layers of mud and later by more decayed plants. As the years went by, it was as if this matter was pressed and tightly sealed in the Earth. It dried and over the two million years it hardened. Some of it got embedded in the rock. That is why when it is mined it is often found in layers. Sometimes you may even see the remains of an old plant in a block of coal.







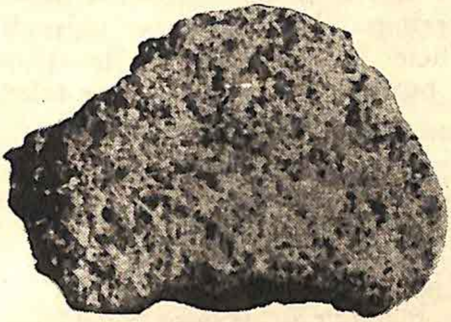


Without coal, a lot of things would be difficult today. It is one of the most important fuels in modern living. Many of us use it in our houses for heating or cooking purposes. From coal we get coke, coal-gas and tar. Coal is burnt in power-houses to make steam. This steam runs turbines which activate motors to produce electricity. Coal is burnt to produce electricity in many parts of our country. From coal we also get a number of chemicals. In Book 4 we saw how coal is used to make plastic polymers from which rayon and other man-made fibres are made.

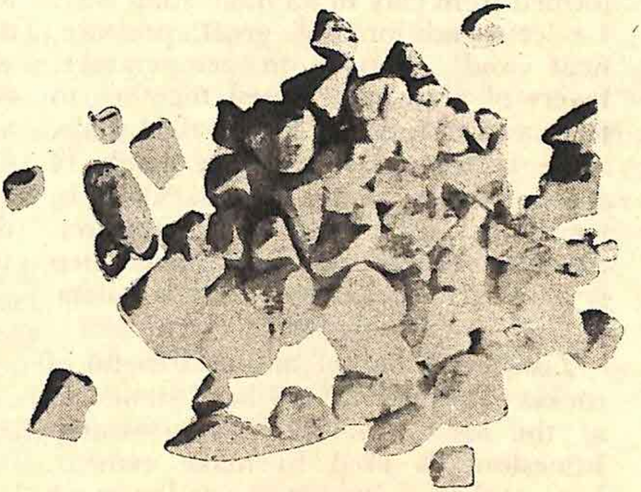
Some coal can be got from rocks on the surface of the earth, but most of it is mined from under the ground. Deep shafts are dug in the ground and miners have to work in the dark depths of the Earth. They have to work in artificial light.

Many kinds of massive rock are really igneous rocks which have melted under great heat and pressure and have formed crystals again. Because of this, massive rock does not have layers of mineral deposit of the kind you see in igneous rock.

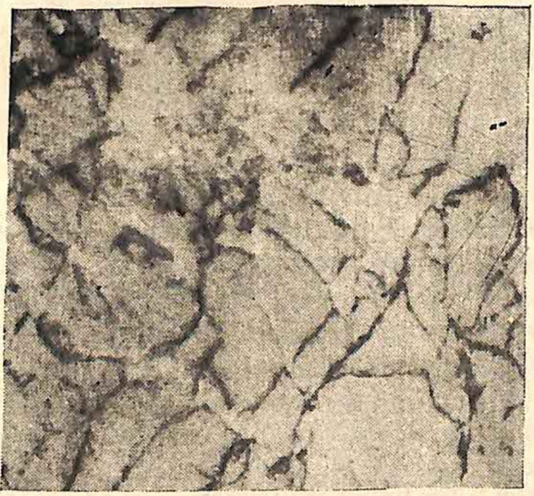
Granite is made of the crystals of a mineral called feldspar and the beautiful crystals of other minerals. It is one of the strongest rocks and is used for buildings. It is used particularly on the exteriors of buildings because it can face a lot of weathering. Granite can be polished. It has small, black specks of a substance called mica which gives the stone its sparkling appearance.



GRANITE



CHALK



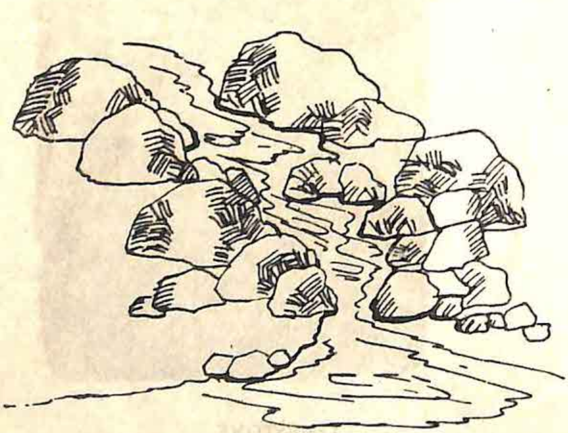
MARBLE

LIMESTONE

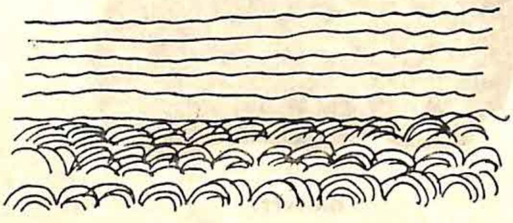
Slate is another useful rock. It is formed from clay in an interesting way. Under conditions of great pressure, heat and changes in temperature, layers of clay are pressed together to form a hard rock. This is called shale. Slate is formed from some kinds of shale. We use it for our blackboards, for tiling and for many other purposes. Slate is not a very strong rock and when it breaks, it breaks into long splinters.

Limestone is one of the most useful of rocks. It is not a very hard stone but at the same time it is very strong. Limestone is used to make cement. Iron and steel industries use limestone to remove impurities in the metals used.

Limestone contains two very similar minerals, *calcite* and *dolomite*. The colours of these minerals vary a lot and limestone can look a greyish-brown. There is a pure, white limestone which we use to make a substance called chalk. This is not the same as the chalk we use to write with. This comes from another mineral, gypsum.



Limestone is formed in an interesting way. Water running over rocks or down a rocky hillside may dissolve some of the calcite on it and carry it away to a river or lake. Here, some of water animals with shells make use of the dissolved lime to make their hard shells and coverings. In time, these animals die. Their lime-worked shells drop to the bottom of the river or lake.



The deposit of shells builds up over hundreds of years and the shells fuse together. This is why limestone is made up of parallel layers.

Another way in which limestone is formed is when the lake or river dries up and leaves the thick lime deposit.

Marble is considered to be one of the most beautiful of rocks. It is a kind of limestone which has crystallised under high pressure and heat. Marble comes in different colours. These colours are caused by the impurities that existed in the original limestone. The finest and probably the most expensive marble is white. The Taj Mahal was built from this. We use it in a number of ways—for floors, wall-surfaces and many other building purposes.

It is difficult to think of a world without metals. If you look around your house or classroom, or even as you walk down the street, you will see so many things that are either made of wholly of metal or which use metal.

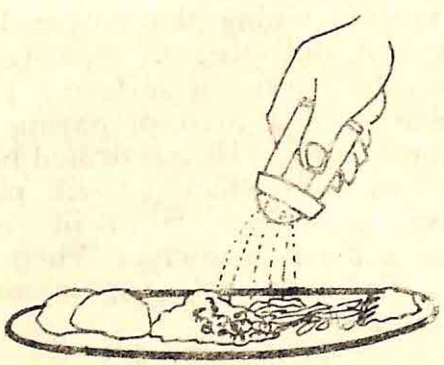
We may wake up in the morning to the sound of an electric bell, which sounds because current passes through the copper wires. Our taps are made of metal, so are many of the vessels we cook in. The pens you write with uses metal. The bus or train you sit in has a body of metal.

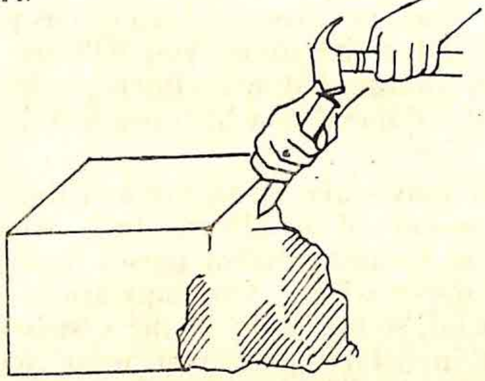
Metals were discovered very early after men first appeared on the earth. At the beginning of this chapter, we saw how the earth was first a mass of molten liquid. This was liquid metal and rock. As the earth cooled slowly, the heavier matter sank deeper into the earth's interior. Some of the molten metal was flung out upwards, nearer the surface of the Earth. Thousands of years of rain cooled the Earth's upper crust and the rocks and metals hardened. Some of these metals became a part of the rocky matter. They can now be found in hard 'seams' in the rock. Such materials are called *ores*. Some metals are found unmixed with rock, and these are called metals in a free state.

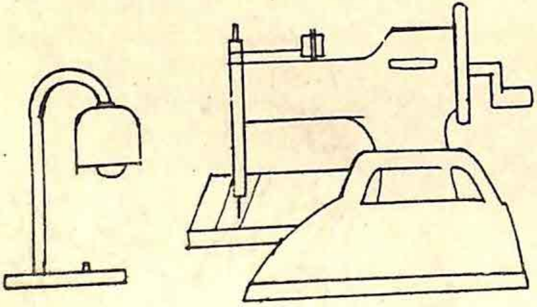
A great deal of the earth's metals is to to be found in its upper crust. Many metals have become 'exposed' as a result of wind and water erosion.

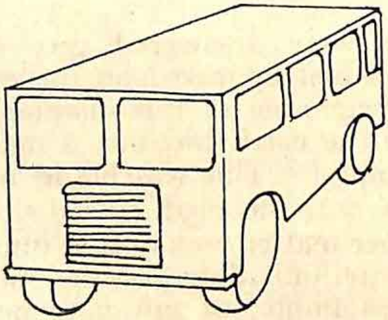
Metals are obtained from their sources in a number of ways. Many metals like gold and ores like iron are obtained by deep mining, that is by making a deep shaft and using an explosive to blast out the ore to the surface. Here is a picture of a man preparing for explosion-mining. He has drilled holes in the rock into which he will place explosive materials. He will then move to a place of safety. When the rock explodes, it may expose metal seams in the rock.

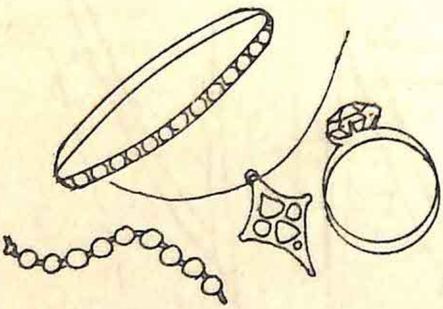
METALS IN OUR LIFE

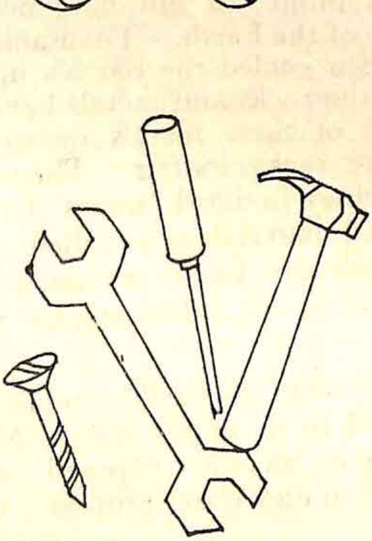












Another way of obtaining metals is panning. Panning is a method of filtering out the metal which is carried in water or which is deposited at the bottom of rivers, lakes and seas.

A method called hydraulic mining is also used to get metal from sand granite. A shaft is made in the earth and water is pumped in forcefully. The force of the water loosens the grains of sand or gravel. The grains of metal being heavier, sink to the bottom and can be collected.

Quarrying is used for metals which are near the surface of the earth. Huge earthmovers are used in metal quarries to shift and heave the ore from under the surface.

THE BASIC METALS

Gold, silver, tin, iron, lead, copper, mercury and zinc are eight basic metals. They are called *basic* because they are pure and are unmixed with the substances of other metals. When two or more metals are mixed to make a third metal, this is called an *alloy*. Over thousands of years, men have learnt to make useful metal alloys. Aluminium, for example, is a lightweight metal and would be excellent for building the bodies of aeroplanes. But it does not have enough strength to withstand the pressures of the atmosphere. It has thus been alloyed with another metal called magnesium. The alloy gives the metals more strength without more weight, which is just what is needed.

Let us look at some of the metals which play a vital part in our lives. Iron is one of these. Many ores like iron are combined with oxygen, and such metals are called metal oxides. Iron is an oxide ore. There are many kinds of iron ores. One of them is blood-red in colour. It is called haematite. Some haematite is found in the form of round lumps, and some in the form of greyish crystals. Another kind of iron ore is magnetite It is the metal from this ore which we commonly refer to as iron.

Iron: All ores have to go through a process of being melted before the metal can be extracted. This process is called *smelting*. In the early days, when iron was first discovered, huge quantities of timber and charcoal were used so that great heat could be produced. About three hundred years ago, it was discovered that coke could be used to produce this heat and precious timber need not be wasted.

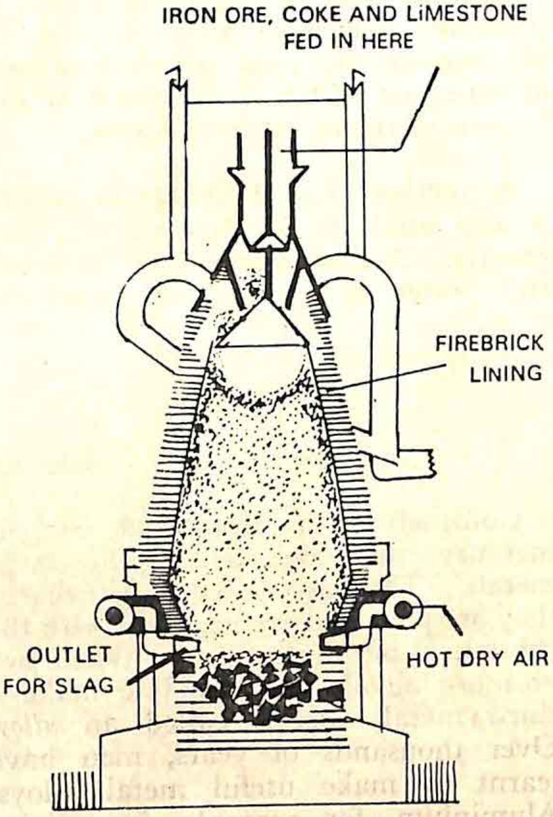
Today, other processes have been found. One of these is mixing the ore with limestone and coke. A chemical action causes the liquid iron to separate from the ore and to settle at the bottom of the smelting furnace (see picture).

Iron is a wonderfully useful metal. It is used for giving the supporting strength to the walls and pillars of buildings. Trains, motor-car bodies and machines are made from iron. So are smaller articles like nails, coal-stoves and some kitchen vessels. Iron is mixed with carbon to make steel. Steel is stronger than iron and can be bent and twisted.

Copper is another useful metal. It was one of the first metals discovered by man. It is malleable, a word used to mean that the metal can be hammered to take various shapes, also that it can be heated to have different hard-soft qualities. Copper is extracted by heating the ore to a very high temperature. It then passes through a long chemical process. One of the most important uses of copper is in electrical wires

Aluminium has become one of the most important of metals today. There is more aluminium in the earth than any other mineral. It is found mixed with clay. Scientists think that if you could collect 100 barrows of clay, there would be enough aluminium in it to make the body of a whole aeroplane!

Although aluminium exists in clay, it is very difficult to extract it. It is largely got from a mineral compound called bauxite. A hundred years ago, when it was very difficult and expensive to extract it, it was a precious metal like gold. Today, we have found simpler ways to extract it. It is available in large quantities and is used to make hundreds of things—from vessels to chocolate foil. Aluminium has great strength, so it is also used to make machine parts and covers.



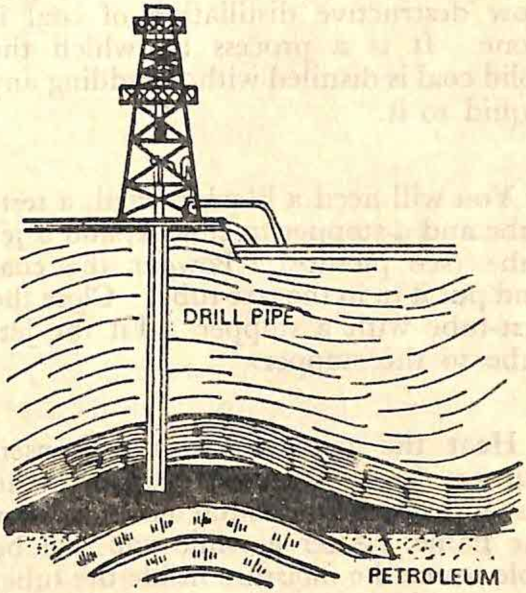
Gold and *Silver* are precious metals. Gold is a 'free' metal and is found in the veins of a mineral called quartz. The quartz is crushed and the gold is extracted by washing away the crushed quartz or by using chemicals. Silver is an ore and is extracted by using chemicals.

Petroleum is an oily, liquid mineral found deep in the ground. It is one of the most important minerals in the world. Think of the many motors, including motor-cars and buses which are run by burning petrol, a product of petroleum.

The petroleum liquid is found deep in the earth and trapped between rocks. This oil is probably the remains of dead land animals and sea plants.

Petroleum is mined by sinking oil wells in the earth. A powerful drill bores through the layers of earth, a distance of between 1-7 kilometres. The force with which the drill drives into the earth causes the oil to be pushed out of the rock. It is then sucked up by machines through a pipe inside the drill. This is crude oil, that is, oil mixed with other mineral impurities. The oil is led out of the well to an oil refinery. Here the oil goes through a process of being separated into various products from gasoline (or petrol) to tar.

Gasoline or petrol is made by a process called 'cracking'. The petroleum molecules are broken into smaller molecules under tremendous heat and pressure. This makes the lighter liquid we call petrol.



Coal and petroleum have several uses in themselves. Their use is increased by making other products which serve the purpose better than the original coal or petroleum. We have seen how petroleum is processed to give us tar and petrol, among other products. There are other substances which are also got from petroleum—diesel oil, kerosene and lubricating oils.

Coal likewise gives us side-products or by-products. By a process called destructive distillation, coal breaks up into different substances like coal gas, gas liquor, gas carbon, coal-tar and coke. Coal gas is used as a fuel. Gas liquor is converted into fertiliser for plants. Gas carbon is used in battery cells. Many chemicals are made from coal-tar including colours and flavourings.

Distilling Coal

Here is an experiment to show you how destructive distillation of coal is done. It is a process by which the solid coal is distilled without adding any liquid to it.

You will need a block of coal, a test-tube and a stopper to close it, and a jet tube (see picture). Powder the coal and put it in in the test-tube. Close the test-tube with a stopper. Fit the jet-tube to the stopper.

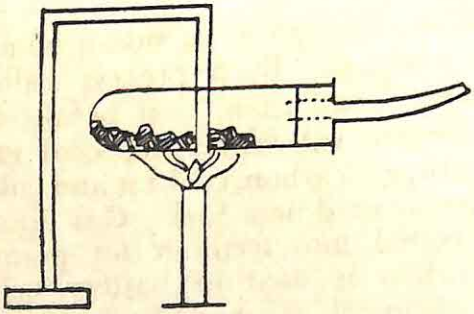
Heat the test-tube with a bunsen burner (or a candle) keeping the test-tube in a horizontal position over the flame. After a while you will be able to see the moisture inside the tube. A gas is forming and escaping through the jet outlet. This gas is a fuel in itself. If you hold a burning match at the mouth of the jet-outlet, you can see the gas burn. You will also see particles of carbon sticking to the inner walls of the tube. At the end of the experiment, you can get the peculiar smell of tar.

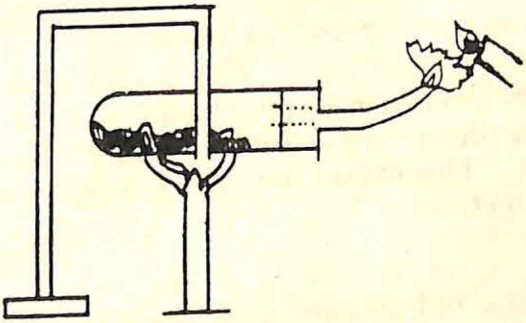
In your experiment, the liquid which condenses is gas liquor. The black carbon-substance is tar, and the gas is is coal gas.

Making Iron and Steel

Iron is one of the most important metals in our world. Without it, there would be no railways, ships, motor cars, tractors. It would be impossible to build a sky-scraper without iron to give the pillars strength.

Men learnt about iron and how to use it more than two thousand years ago. In those times, iron was extracted from the ore on a charcoal fire. When the fire died out, a lump of iron was left behind. This could be hammered into shape and was used for simple tools and weapons. Very soon they found that if bellows were used, more air could be pumped into the closed furnace to increase the heat in the furnace. In this way men learnt to separate the ore from the metal.

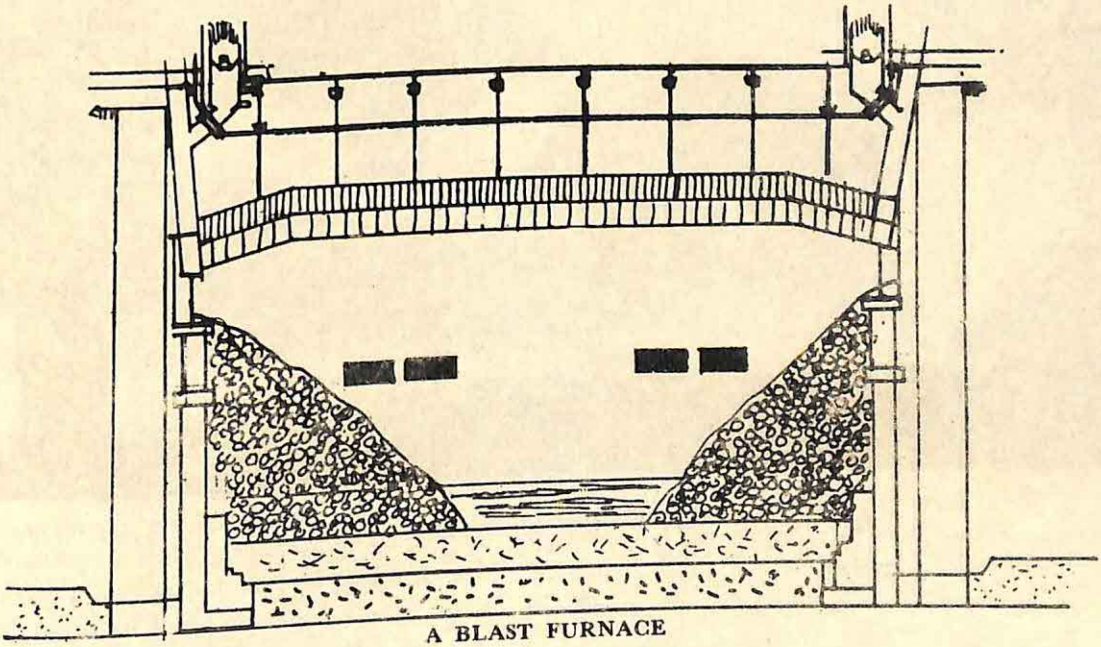




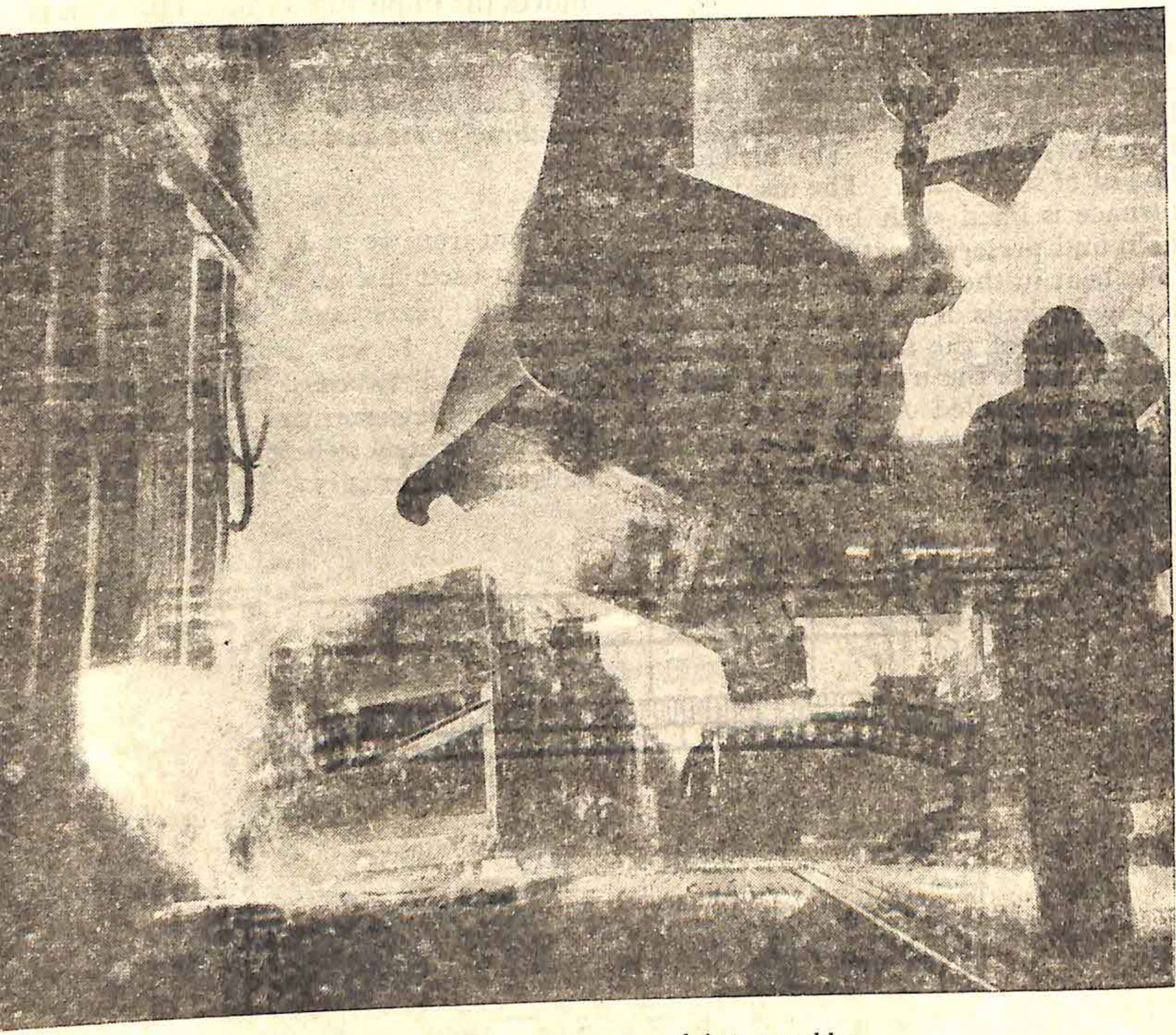
About two hundred and fifty years ago, a man called Abraham Darby showed how iron could be smelted with coke instead of with coal. This was a great discovery because coal was very expensive. Later, limestone was added.

The method is to first mix the raw ore with certain quantities of coke and limestone, and feed them into a blast furnace (see picture). The furnace has layers of steel walls. The inside of the furnace is lined with brick which can hold and preserve heat for a long time. The heat in the furnace is increased by letting in shafts of air through a channel at the base of the furnace. A chemical action causes the iron to smelt and the molten iron is led out. When it cools it forms solid iron bars or blocks. This is called pig iron. It is strong and can be used for many purposes. Most of it is used for making moulded things. But cast iron breaks when it is bent, it is brittle. To give iron the quality of bending without breaking it has to go through a process of heating which removes the impurities in it. This iron is wrought iron. We make furniture, wire, chains, nails and other things with it. Cast iron is used for railway tracks, machine parts and many kinds of tools.

From iron we make *steel* which is the highest-used metal in the world. A hundred years ago, steel was very expensive. It was used only to make springs and swords. A new process, called the Bessemer process, has made it possible for steel to be produced cheaply in great quantities. In this process,



A BLAST FURNACE



Molten pig-iron being poured into moulds air is blown through molten pig-iron mixed with manganese and silicon. It removes the impurities present in the iron.

Steels are of various kinds. It is alloyed with other metals to give it certain additional qualities. A hard steel is manufactured by increasing the amount of carbon in it. This is used for machine tools. For building purposes, steel is alloyed with chromium and nickel. Stainless steel is made by adding chromium and other elements to steel. Many of us use stainless steel vessels.

METALS IN OUR WORLD

Why do we use metals? Why do we use bricks or concrete or stone? We use these things because they are suitable for the purpose for which they are used. They have the required strength or other qualities. They may have the quality to last longer than other things. When we use something, we also have to think about how much it costs. Could we save costs by using something cheaper but equally good?

Metals play such an important part in our lives, that we are becoming more and more dependent on them. So much study has been done on metals that we know a great many metals. We know many of the qualities they have.

Most of the metals we use today are alloys. The good qualities of one metal are combined with others to give us a new metal. This metal will have the best qualities of all the metals which have been used to make it.

Scientists and metallurgists (people who study metals and their uses) are trying to find out how metals can be used and combined in new and different ways. For some purposes, it is impossible to do without metal. A concrete pillar of a building, for example, is not strong enough in itself to support many storeys built above it. It needs a core of hard steel to give it the necessary strength. In building, the strongest things are concrete and steel.

In many other ways, metals may have to take the place of other things which have been used so far. Plastics are excellent for many purposes but they do not have strength. They have a short life. They are also difficult to recycle—a word we use for passing a used material through a process so that it can be used again. In the future, therefore, we may use more and more metals. Metallurgists will think of new alloys. Scientists may find new qualities in metals. The same metal may, in this way, be used for more and more purposes.

1 What are minerals and how were they formed?

2 What are the basic forms of rocks? How did these formations take place?

3 Why is coal called a sedimentary rock? Explain how coal was formed.

4 What would happen if we used up all the world's coal? Would we be able to 'make' any more? How, or why not?

5 Coal played a very important part in the discoveries about metals and ores. Describe how this was so.

6 Write short notes on iron, granite, slate, marble, aluminium, gold and silver. Make a simple list of their uses.

7 Which of these can be polished: granite, silver, marble, slate, limestone. Why cannot the others be polished?

8 What are alloys? Why did men think of alloys?

9 Write a note on how limestone was formed.

10 Explain how it is that metals are found

   a) in the veins of rocks
   b) in the sea
   c) in the soil

11 Which metal is found on the Earth in the greatest quantity? Why is it difficult to get enough of it?

12 On which of these does our getting metals from the earth depend:

   a) on how much the earth has
   b) on where it is present
   c) on how easy or difficult it is to obtain and smelt the ores
   d) on how expensive it is to mine for metals.

13 What are basic metals? What properties do basic metals have?

14 How are metals mined?

15 Draw a simple diagram to illustrate this description of making steel in a device called a Bessemer converter.

The converter has a shape like a concrete mixer. It is fitted in such a way that it can tilt as low as necessary. It has an inlet at the side near the base to let in air. It is first tilted to receive molten pig iron. It is then straightened. Air is blasted in through the inlet at the side. As a result of a chemical change, the impurities from the iron are removed.

The converter is then tilted again to pour out the liquid iron into a large ladle. Here, a metal alloy is added to the iron. This makes liquid steel.

16 Why are some metals more expensive than others? Think of at least 3 reasons.

17 What properties does aluminium have? What is one of its most useful properties?

18 Describe how petroleum is mined.

19 What process does iron ore go through? How is cast iron different from wrought iron? From steel?

20 Why are metals important to us? Why would plastics and wood not be able to replace metals completely?

1 Make a list of all the things in your classroom which use metal. Try to identify what metals they are.

2 Take a piece of iron and copper. Wet them in water and leave them for a few days. Which of them has rusted? Why didn't the other rust?

3 Watch your teacher do this experiment.

Melt small pieces of various kinds of metals over a strong flame (a bunsen burner is good enough). Which metals melt easily? Which do not melt?

4 Take pieces of various kinds of rock. Heat them by holding them over a flame. Which ones crack when you plunge them in cold water?

5 Collect five different kinds of rock. Examine and draw them in your books. Can you say which ones are sedimentary and which are metamorphic?

6 *a*) Collect 10 different kinds of rock. Break each by dropping them from a height or by a blow with another, heavier stone. In what different ways do they crack small, irregular bits; splinters; thin sheets. Make notes on these.

b) Take a thick sheet of black card. 'Write' over it with different kinds of rock. Which rocks can you write with? Which rocks leave no impression?

c) Rub the rocks over a hard, rough surface. Which rocks flatten in the process? Which rocks are difficult to flatten?

7 Make a list of things in your house which are made (or parts of which are made) of metal. In another column write down whether you have seen or heard about the same

thing made of plastic, a tea-strainer for example. Now compare the two along the following points:

a) Which is easier to handle?
b) Which is easier to clean?
c) Which one will crack or break?
d) Which is cheaper?
e) Which is safer?

Fill in the blanks:

a) Ore is a mineral dug out from the ————.
b) Rocks and minerals used for extracting metals are known as ————.
c) ———— is an iron ore.
d) Diesel is got from ————
e) ———— and ———— are precious metals.
f) ———— is converted into steel.

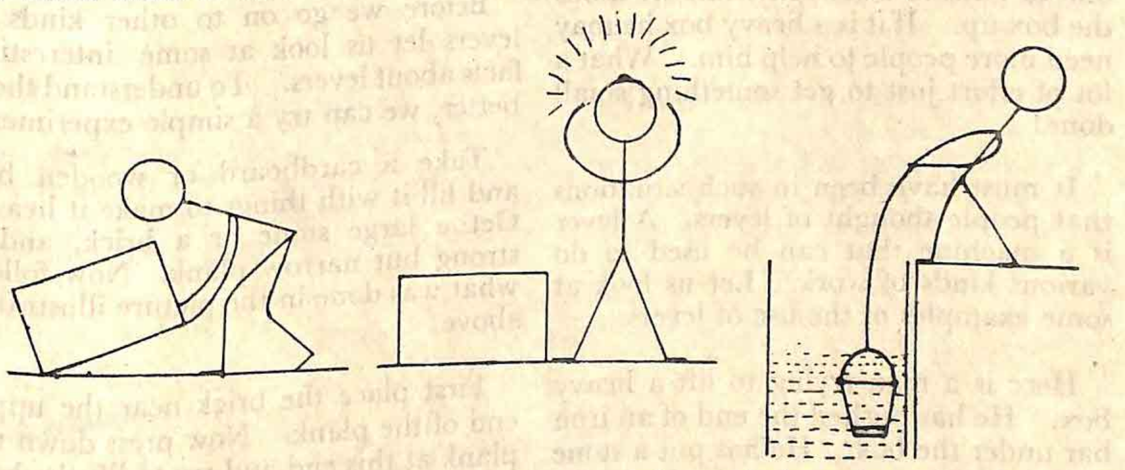
9 What metals are used to make these?

a) boilers
b) electric wires
c) foil used to wrap chocolates
d) pressure cookers
e) bulb holders.

3 SIMPLE MACHINES

In Book 3 and Book 4, we learnt about work. We learnt about how we make our work easier by using devices like wheels and pulleys. We will now learn about some other wonderful helpers—levers, pulleys and wedges, and a few others.

Ever since men began to work, they found that there was a great deal to be done if they were to make the world a better, safer and happier place to live in. Some kinds of work were easy but a lot of work was difficult. It meant using great amounts of energy. Sometimes the effort was wasted if the man got tired in the middle of the work. Thus if a man tried to lift a heavy box, he might well find after he had lifted it up a bit that he could not bear the weight any longer. He would let the box down again and his work would be wasted. Or he might try to lift a bucket of water from the well with a rope tied round the handle. What an effort *that* is!



So people began to think of ways of making work easier. They invented machines for this purpose. A machine would not cut out all the effort a man had to put in to make it work, but it certainly made it easier. It also made the work somewhat simpler. With a machine, the same effort could be used to get a lot more things done, or the same work done more quickly.

In course of time, a lot of simple devices or methods were discovered and they were used in machines. One of these was a lever (pronounced lee-ver).

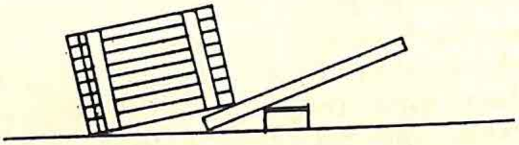
LEVERS

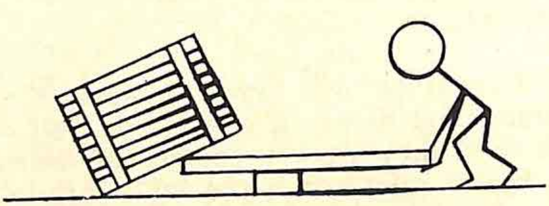
In getting any kind of work done, a *principle* of some kind is used. These principles are laws of nature by which an action of some kind will have a certain result. This result will be the same every time the action takes place. The lever is a principle of work.

Like all things, levers were invented because of problems of a certain kind. Imagine a man trying to lift a heavy box up at one end so that he can move out a book from underneath it. He will almost certainly need help, someone to remove the book while he holds the box up. If it is a heavy box he may need more people to help him. What a lot of effort just to get something small done!

It must have been in such situations that people thought of levers. A lever is a machine that can be used to do various kinds of work. Let us look at some examples of the use of levers.

Here is a man trying to lift a heavy box. He has pushed the end of an iron bar under the box. He has put a stone under the bar, very near the box. He can now lift the edge of the box by holding the other end of the bar and pressing it down. This is an example of the use of a lever. The iron bar is the lever used to lift the box. It is a simple lever.



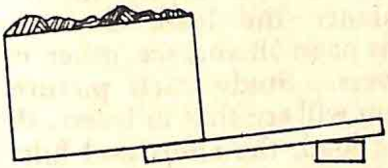


Before we go on to other kinds of levers let us look at some interesting facts about levers. To understand them better, we can try a simple experiment.

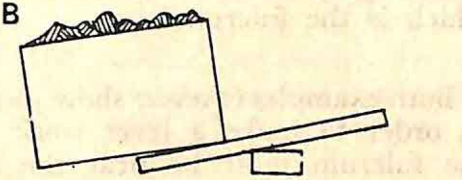
Take a cardboard or wooden box and fill it with things to make it heavy. Get a large stone or a brick, and a strong but narrow plank. Now follow what was done in the picture illustrated above.

First place the brick near the upper end of the plank. Now press down the plank at this end and try to lift the box. Now move the brick somewhere near the middle of the plank and try to lift the box in the same way. Finally, move the brick close to the box and press at the other end of the lever.

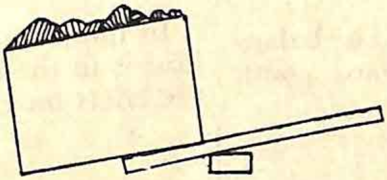
A



B



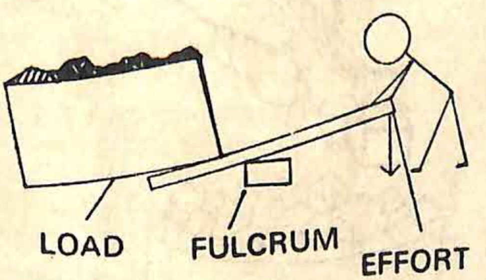
C

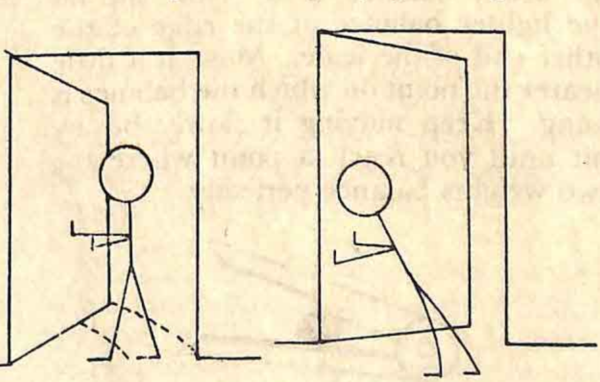


Which is easiest, that is, which of these helps you lift the box with the least effort?

If you have tried the experiment accurately, you will find that trial C requires the least effort. Now look at picture C again. The plank is the lever. Three things are at work when the lever moves. The first is the *load*, the box. The second is the *effort*, that end of the plank which you press down to lift the box. It is here that you apply the effort of pressing. The brick is the *fulcrum*, the fixed point on which the lever moves. The fulcrum can be changed as you changed it by moving the brick (trials *A*, *B* and *C* above), but once you work the lever, the fulcrum is a fixed point. It does not move. It is the point on which the lever turns. A lever, therefore, is a rod that moves on a fixed point. The **farther** you are from this point, the easier your effort.

Another simple lever is at work when you try to close an open door. If you press it at a point near the hinges it will be difficult to shut it. You can shut it quite easily by pressing at the

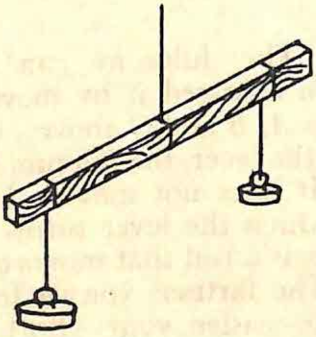


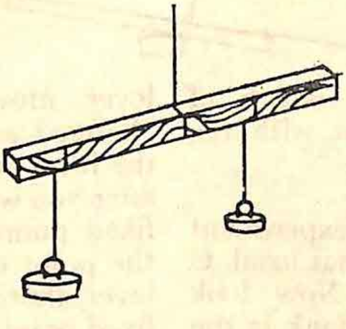


other edge of the door. In this example, which is the fulcrum?

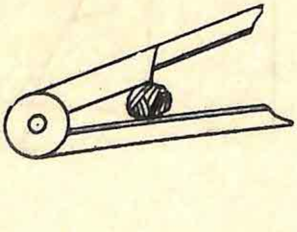
Both examples of levers show you that in order to make a lever work well, the fulcrum must be near the load. The farther away it is, the more difficult it is to get the same lever to work.

Balances are also levers. The balancing rod is moving on a fixed point.



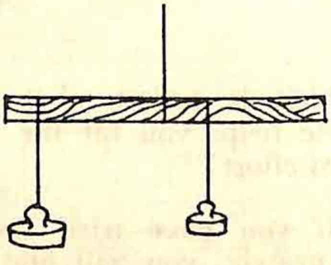


You can make your own balance as shown in the picture. Now take two unequal weights and tie a string round each of them. Leave a loop so that they can be hung on the balance. Hang the heavy balance first. Now slip on the lighter balance at the edge of the other end of the scale. Move it a little nearer the point on which the balance is hung. Keep moving it slowly bit by bit until you reach a point where the two weights balance perfectly.

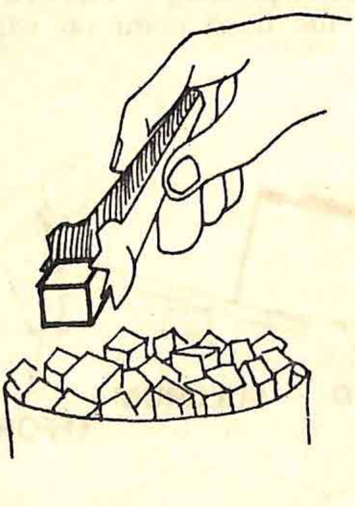


In this example, the effort is to balance the load, the two weights. On page 58 you see other examples of levers. Study each picture carefully. You will see that in levers, the points of the load, the effort and fulcrum differ. Sometimes, as in opening a tin, the fulcrum is in the middle, with the load and the effort on either side.

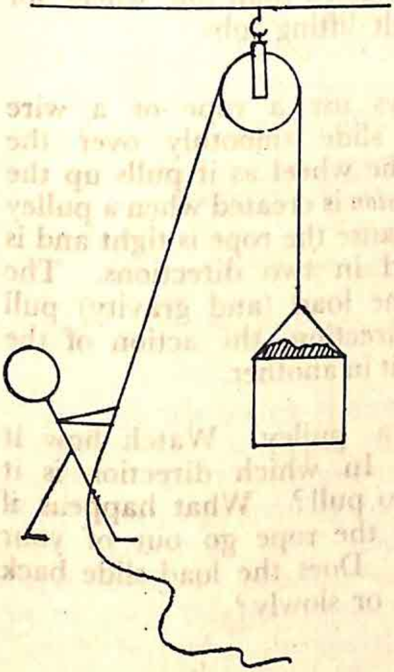
In the picture of the nutcracker, the load is in the middle, the fulcrum and the effort on either side.



When we use a pair of tongs to lift a cube of sugar from a bowl, this is a third kind of lever. The effort (pressing) is in the middle.

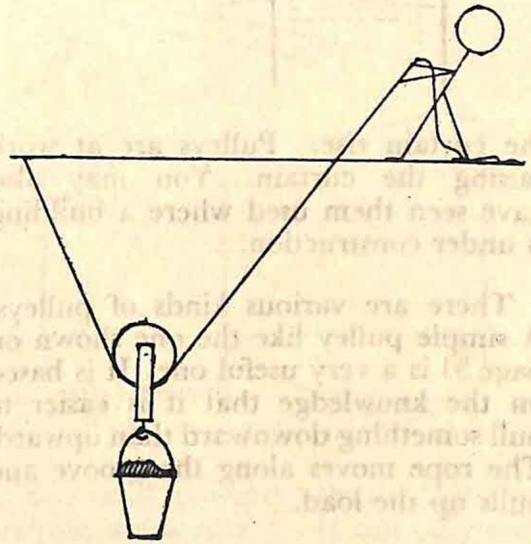


In Book 3 you learnt how to make a simple pulley with a cotton reel. Here are some other examples of pulleys.



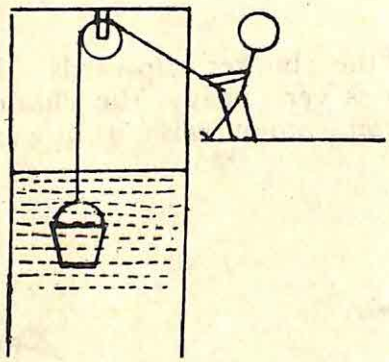
A pulley, like a lever, is a machine that helps us do some kinds of work more easily.

Sometimes objects have to be moved in the direction opposite to the one in which a force moves them. Take the example of a well. When a bucket of water is let down into it by means of a rope, there is only a slight pull in the downward movement of the bucket. But when it fills with water, its weight together with the downward-pulling force of gravity pulls it strongly *away* from the person holding the rope. A difficult effort has to be made to move the bucket upwards. If the bucket is very heavy, the chances are that you cannot raise it upwards on your own strength. You need a pulley, a machine that works on the principle of wheels.



Look at the picture on page 52. The is man using a pulley to haul up the bucket. The moving wheel of the pulley has *changed the direction* of the force. The bucket can now be hauled up without much effort.

Pulleys are used in a number of ways. When you hoist a flag, you use a pulley to move the flag up along the flagpole. When you go to the cinema, you see



the curtain rise. Pulleys are at work raising the curtain. You may also have seen them used where a building is under construction.

There are various kinds of pulleys. A simple pulley like the one shown on page 51 is a very useful one. It is based on the knowledge that it is easier to pull something downward than upward. The rope moves along the groove and pulls up the load.

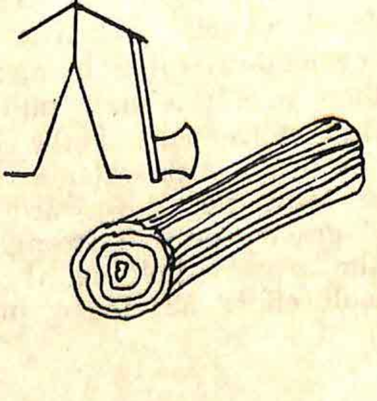
Depending on the load and the kind of lifting required, there are pulleys which can do more work for less effort. Some of these pulleys are moving pulleys (page 51, right). There are pulleys with more than one wheel for more difficult lifting jobs.

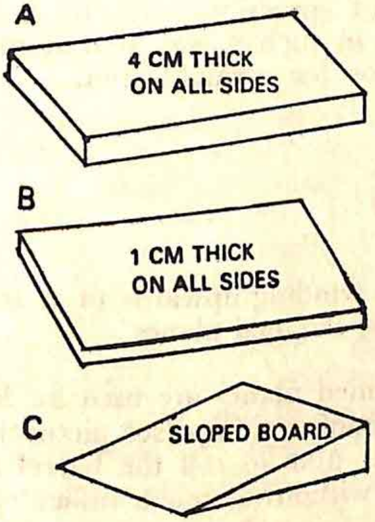
All pulleys use a rope or a wire which can slide smoothly over the grooves of the wheel as it pulls up the load. A *tension* is created when a pulley is in use because the rope is tight and is being pulled in two directions. The weight of the load (and gravity) pull it in one direction, the action of the pulley pulls it in another.

1 Make a pulley. Watch how it works. In which direction is it easier to pull? What happens if you let the rope go out of your hands? Does the load slide back quickly or slowly?

WEDGES

A wedge is a simple but effective device for splitting solid substances like wood. Here is a man trying to split a log. He has a mallet and three wooden pieces with him. One is a solid wooden board about 4 cm thick on all sides (board A). The other is a thin board, less than 1 cm thick on all sides (board B). The third is a board with a 'slope', it is thin at one end and thick at another (board C). He has made a small split in the log with his axe.



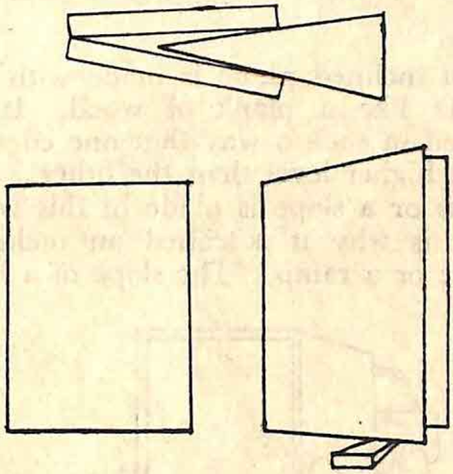


He now fits board A into the slit and hammers on the other edge with the mallet. The board moves a little at first, then stops moving into the wood. The man now tries board B. The edge he has to hammer on, is so thin he misses it the first time. The second time he hits it but the board breaks!

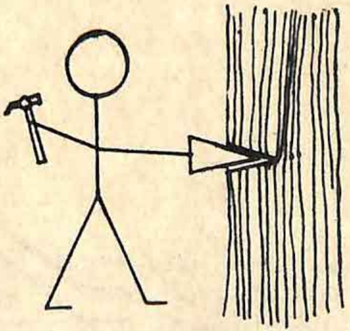
The man now tries board C. He fits in the thin end into the slit. He then hammers neatly and easily on the thick end. A few blows and the log splits!

Board C is a wedge. It works because the thin end is sharp enough to pierce through the wood. The thick end is wide enough to take the full force of the hammer blows. As the wedge moves in, it widens the split because the thicker parts of the wedge follow the thin edge. What would otherwise take a very long time and a great deal of effort is done in an easier way.

Wedges are used to split things like wood. It is also used to separate two parts of objects which are in tight contact through pressure. Wedges also make useful door jambs.



You must remember that a wedge is a splitter, not a cutter. It can only split things like wood. If you try beating a wedge into a log of wood you will notice two things: *a*) how easily the wedge slides in and *b*) how difficult it is to control the *direction* of the split.

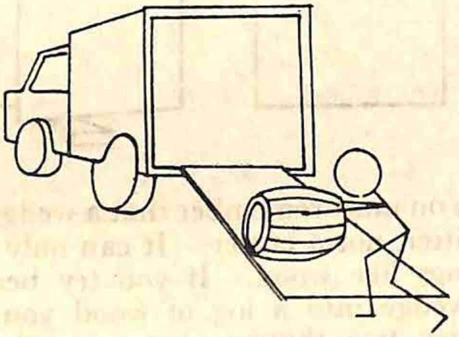


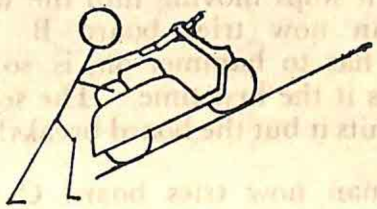
If you are not careful, the log can crack at an angle, not in a straight line. People who drive wedges learn by constant practice how to beat the wedge in such a way that it makes a more or less straight split.

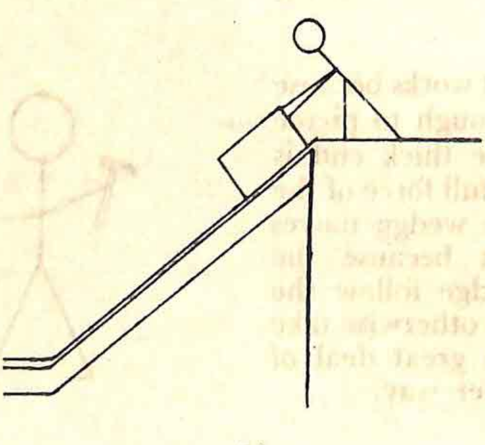
INCLINED PLANES

An inclined plane is made with an object like a plank of wood. It is placed in such a way that one edge is on a higher level than the other. An *incline* or a slope is made in this way. This is why it is called an inclined plane or a ramp. The slope of a hill, a road winding upwards or a staircase are also inclined planes.

Inclined planes are used for loading or unloading things (see picture). The man is able to roll the barrel up the plank without as much difficulty as he

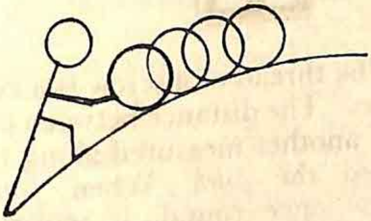




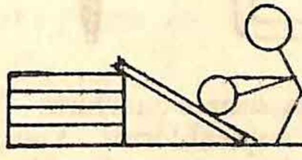


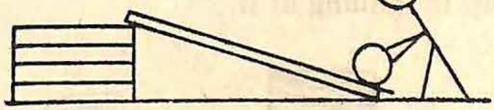
would have carrying it up all the way. The man with the scooter is also able to take it up the ramp easily. If you have tried taking your bicycle up a flight of steps, you will know how much easier it is to use a ramp. In the same picture you can also see a man sliding a load down an inclined plane. With the slope, the load moves easily.

Inclined planes also help us mount a load more easily onto a platform on a higher level. They make the movement of an object from the plank to the platform smooth. The picture shows you how this happens.



There is another interesting fact about inclined planes. The *gentler* or more gradual the slope of the plane, the less is the effort required to slide the load up the plane. This is also the reason why it is easier to walk up a gradual slope than a steep one.

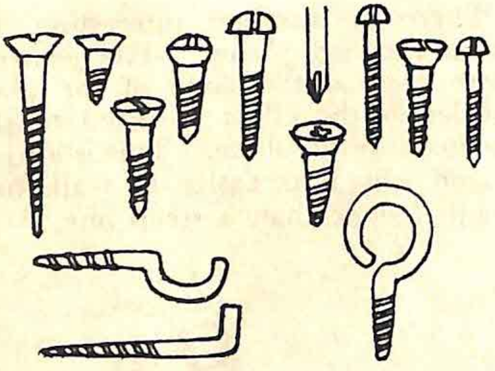




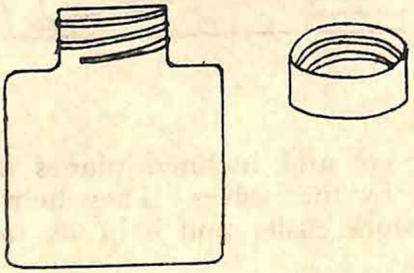
Levers and inclined planes do not work by themselves. They help make our work easier and help us use less force.

SCREWS

All of us have seen screws. If each one of you brings a screw to class, you will have a collection of screws of different shapes and sizes. The heads may be different, but all screws have something in common—the threads.

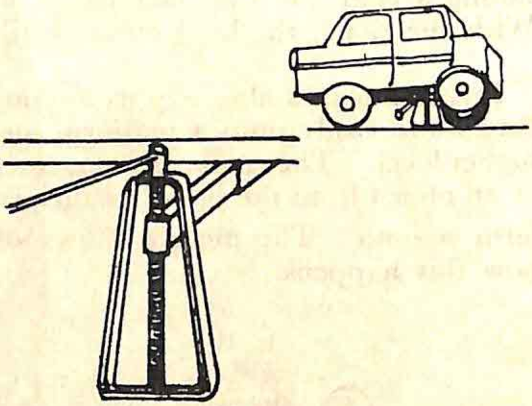


A screw is a simple machine. The threads are in a spiral form. You find screwing threads on the necks of bottles and jams. The caps of some jars also have thread-grooves. When you screw on the cap, the threads fall into place with the grooves. The bottle is now shut tight and you cannot remove the cap by pulling at it.

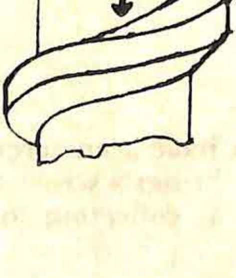


A screw is used when you want to join two pieces of wood or metal with force. Without a screw, we would have to hammer a nail in. This involves a number of blows of the hammer. With a screw, the effort is made easier because the threads help it move down by itself as you screw it in. The threads also make sure it does not come out easily.

The principle of the screw is used in a jack. You may have seen a lifting jack hold up a motor car so that the wheel can be removed or fitted back.

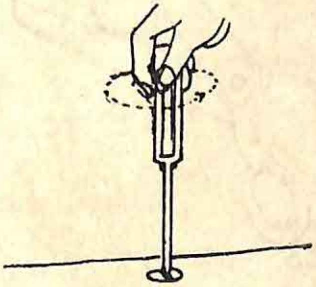


The thread of a screw is a continuous slope. The distance between one thread and another measured along the axis is called the *pitch.* When you turn a screw once round, it moves down a distance equal to its pitch.

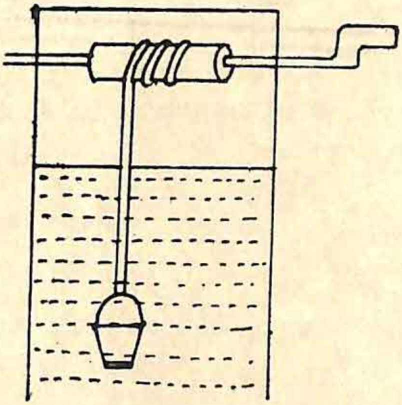


In its simplest form, a wheel-and-axle device consists of a wheel connected to another, smaller wheel called the axle. When the larger wheel turns, it turns the axle also. The effort required to turn a large wheel is less than the effort required to turn the small wheel.

Let us look at the example of a screw-driver which uses the principle of the large wheel and the small wheel. We must first remember that there are no wheels in a screw-driver but it makes a circular wheel-like motion when it turns a screw. The larger 'wheel' is the movement at the top where you hold the screw-driver. This large 'wheel' turns the small 'wheel', the circle made by the screw-driver blade turning the screw. A small effort makes the job easy. Think how difficult it would be to turn the screw-driver blade if the handle was not there. The same kind of action with less effort is made possible in a cycle pedal.



A windlass is a wheel and axle machine. Here is a picture of one used in a well. The handle serves as the wheel, and the reel is the smaller wheel or axle. The wheel and axle make work easier because the effort needed to turn a large wheel is less than the effort needed to turn a small one. This is why it is easier to screw on a large screw than a very small one.



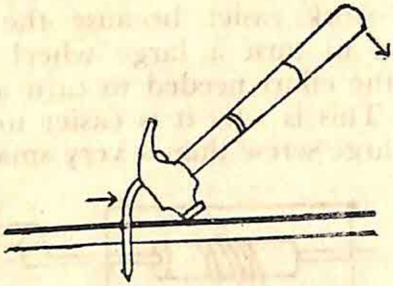
1 What is a lever?

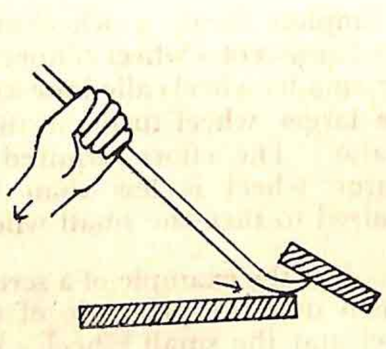
2 Draw the levers on page 58 in your books. Try to label the load, the fulcrum and the effort in each of these. Your teacher will help you.

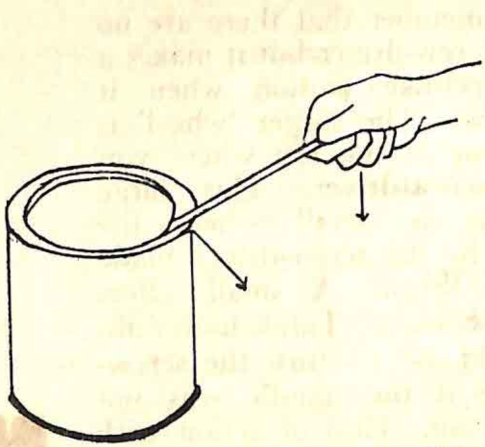
3 What would you use if you wanted to lift something easily—a long lever or a short lever? Explain why.

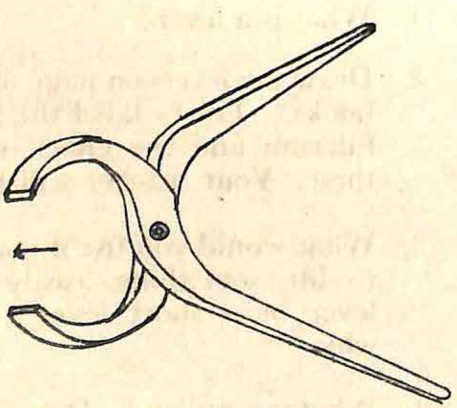
4 What is a pulley? Describe how a simple pulley works.

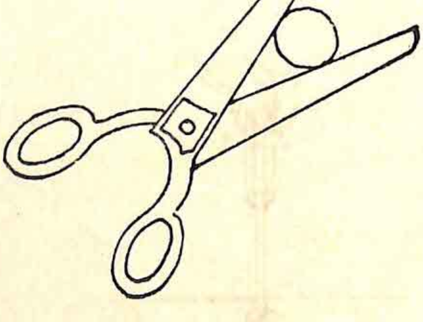
LEVERS



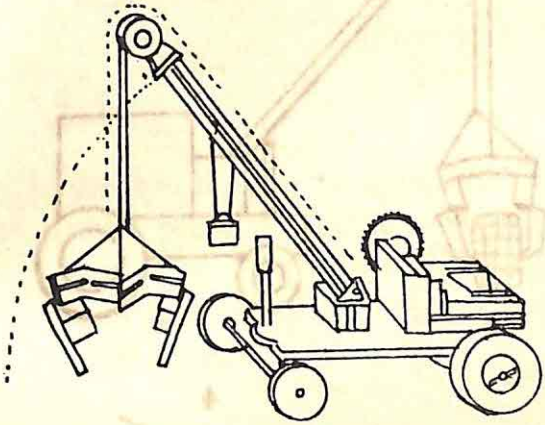








5 Look at this picture of a crane. Lable the two fulcrums A and B.



Fill in the blanks using the words given:
ground lever A B pulley lift.
This crane is both a ——— and a ———. The ——— helps to lift the crate from the ground. The ——— then takes over to ——— it to a height where it can be placed on a high platform. When the lever lifts the load, the fulcrum is at point ———. When the pulley hauls it up, it is at point ———.

6 What is a wedge?

7 Why must wedges be made of stronger wood or metal than the wood they are splitting?

8 Do you need to use a wedge in a slender log of wood? Why, or why not?

9 Find out why you cannot use a wedge to split metal.

10 Why does using a wedge need practice?

11 Which of these can be used as a wedge:

screw-driver cork-screw pliers.

12 What are inclined planes? How are they useful?

13 Why is it easier to push a load up a gradual incline than a steep one?

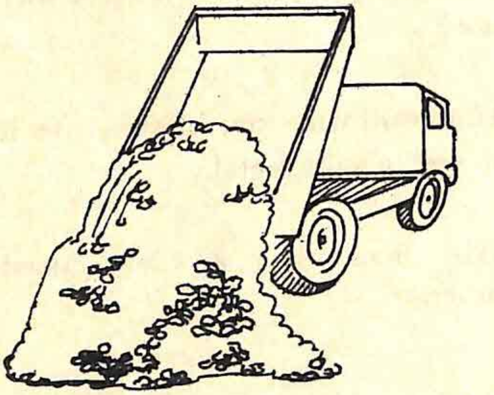
14 Why are screws better than nails when you want to join two pieces of metal or wood tightly together?

15 Think of 6 different instruments which use a screw.

16 What is the principle of the wheel and axle?

SIMPLE MACHINES

1



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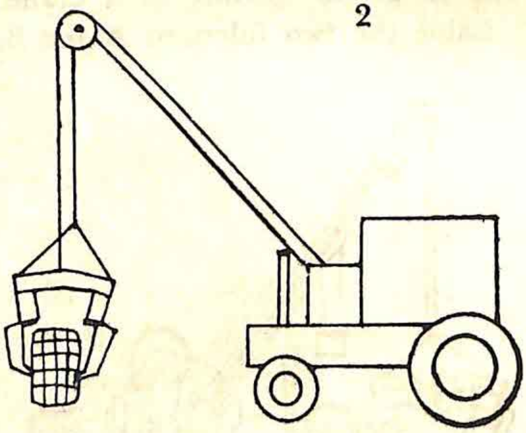

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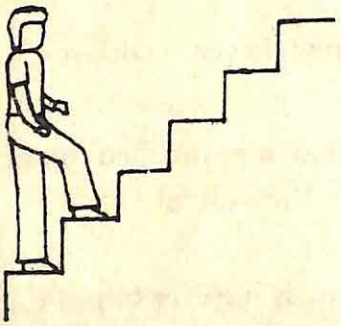

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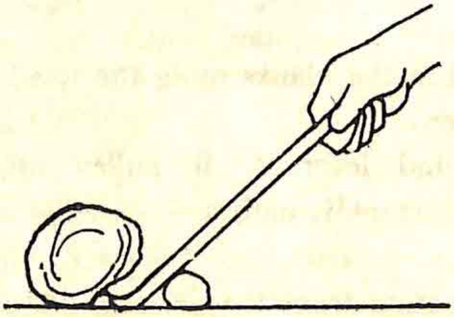

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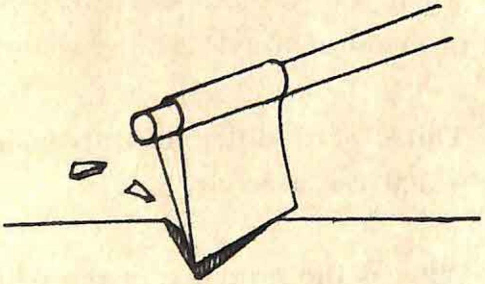

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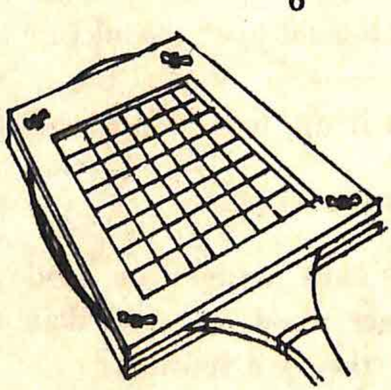


17 Look at page 57 and read the portion on how a screw-driver works. In the same way explain how cycle pedals work.

1 Look at the picture on page 60. All these people are doing work. They are using different kinds of simple machines. Say what kind is being used in each.

2 Fill in the blanks with suitable words

a) Both ——— and ——— are used to draw water from a well.

b) A ——— may be used for raising motor cars and lorries for repairs.

c) An ——— is often used for loading things on a truck.

d) Tongs are a kind of ———

3 **Draw diagrams to show**

a) a lever used to open a tin.

b) a pulley used to lift a load.

c) a wheel and an axle.

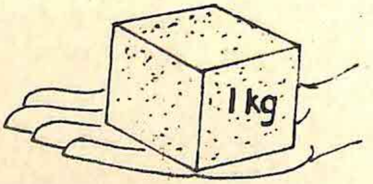
d) an inclined plane.

5 WEIGHT, MASS AND DENSITY

In this chapter we are going to make an interesting study of some properties of matter. Matter, as we know, exists on Earth in three forms — solid, liquid, and gas, or in between these.

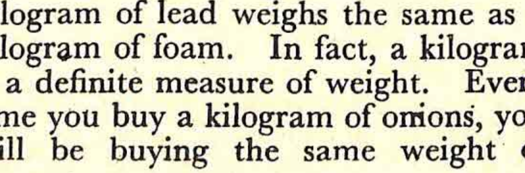
All matter, as we know already, has weight. To the normal weight that an object would have is added the pulling force of gravity and often the pressure of air. Weight is therefore a combination of all these.

Now let us look a little more closely at weight. Suppose someone asked you to hold a kilogram of iron in one hand, a piece of polysterene foam (popularly called thermocole) also weighing a kilogram in another. You may say, 'The iron feels heavier than the foam.'



Actually, you would be quite wrong, and a scientist would tell you so. Both the iron and the foam weigh *the same* because they are both a kilogram in weight. They are equally heavy.

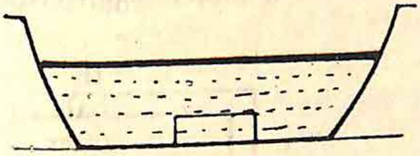
When we say something is heavier or lighter than another thing, we are usually thinking of its size. Suppose you now hold a block of iron the size of a cigarette packet in your hand and a cigarette packet in the other. You would surely find that the cigarette packet, which is probably made of cardboard, is much lighter than the block of iron. Remember that they were the same *size* and volume.



Earlier in this chapter we saw how a kilogram of lead weighs the same as a kilogram of foam. In fact, a kilogram is a definite measure of weight. Every time you buy a kilogram of onions, you will be buying the same weight of onions. The first principle of weight, therefore is that everything weighs the same.

Why then, is the block of iron heavier than the cigarette packet? They are the same size, they look as if they should weigh the same, but they do not. The reason is that their *mass* and *density* are different.

What are mass and density? Mass is a word used to describe how tightly or loosely the molecules of a substance are packed together. All materials differ in their density. The kilogram of iron and foam may have weighed the same but they were of different densities. If you put them in water, the iron will sink but the foam will float.



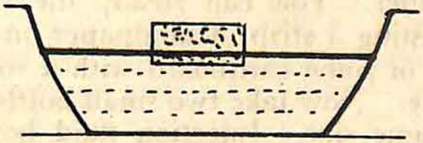
LEAD

When we want to compare the densities, we need something to measure them against. The density of liquids and solids is measured against water. We know, for instance that the density of cast iron is seven and a half times that of water.

Metals have different densities. Iron is denser than aluminium. Aluminium is denser than water. But water is denser than cork or kerosene. Substances which are less dense than water float in it.

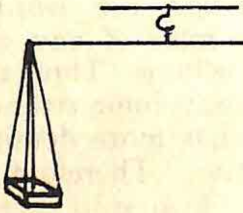
When we talk about the mass of a substance, we use the word *density*. Density is the mass of any substance in terms of its volume. Thus, the block of iron is the same volume as the cigarette packet, but it has more density, more mass or matter. Therefore, it has more weight. Two substances of the same volume differ in weight not because they are different substances but because their densities differ.

Iron has more density than cardboard or wood. The density of water is somewhere between these two. This is why lead sinks in water. A piece of wood of the same volume would float on water. So would cork. We can therefore say that different materials have different densities.

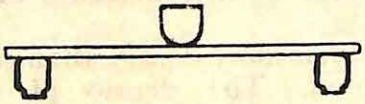


CORK

You can use a suspended balance or a see-saw balance to find out how materials of the same volume are denser than others. Picture A is a simple balance made with matchboxes of the same size.



A



B

Picture B shows you a see-saw balance for which you need a small block of wood curved at the top, and a broad foot-ruler. You can steady the ruler by pasting a strip of sandpaper on the block or some cardboard with a rough surface. Now take two small bottles of the same size. Injection fluid bottles would serve very well, and you could get them from a chemist. Now paste the bottles firmly to the edges of the ruler with a strong adhesive. Set up the see-saw balance and **compare** the density of different kinds of liquids.

Here are some suggestions about things to weigh in the matchbox scale and the see-saw balance.

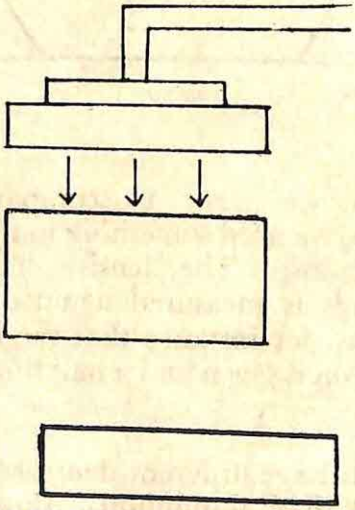
Matchbox-scale: sand and sugar; rice and wheat; coffee powder and tea; coriander seeds and mustard seeds; two different kinds of leaves chopped up and packed tightly into the boxes.

Make sure everything is put *level* into the matchboxes.

See-saw scale: Honey and water; ink and liquid glue; salt water and coffee; oil and water.

In both balances you get the same volume because the matchboxes are of the same size, and the bottles are identical. Make notes of which is heavier than which, every time you weigh.

Here is another interesting point about density. Suppose a substance changes its volume, i.e. it shrinks or expands. Its density will now change. This is because density is related to volume. For example, if we put a block of wood under a powerful press,



A BLOCK OF WOOD PRESSED TO HALF ITS ORIGINAL THICKNESS we can reduce it to half of its thickness. Its weight would not change, but its density would double!

1 What are the two properties of matter you have just learnt about?

2 If all substances weigh the same, why do two substances of the same volume differ in weight?

3 Which of these statements is correct?

  a) Weight gives a substance density.

  b) Density gives a substance weight.

  a) Iron sinks in water because iron is made of a heavier substance.

  b) Iron sinks in water because it has a greater density than water.

4 Say whether these statements are correct or incorrect, then explain why the incorrect ones are so:

  a) Aluminium is denser than iron.

  b) Aluminium is lighter than copper.

  c) An apple weighs less than an orange.

  d) Gases have no density.

5 **Arrange the following substances in the increasing order of their densities:**

cork, aluminium, iron, water, gold

Make a table of 6 substances which are heavier than water and 6 substances which are lighter.

6 HOW LIVING THINGS SURVIVE

One of the most remarkable facts about the world of living things is that more than a million kinds of plants and animals live together. A better word than 'live' is *survive*, because life for all living things is a matter of struggle and of changes to which they must adapt themselves. By their very nature, all living things fight against death and against being destroyed or wounded. They fight to survive and live healthily.

THE CYCLES OF NATURE

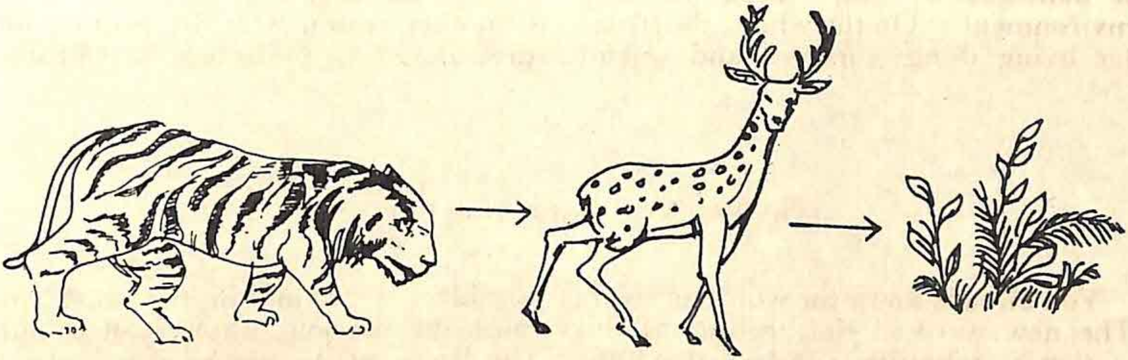
Why do plants and animals have to *struggle* for survival? **In what way is a plant linked** with another plant or animal or anything in its environment? The answer to both these questions is that:

1 most living things have enemies or rivals of some kind or other. They are enemies in the sense that they can kill, destroy or eat, and rivals in the sense that they compete for the same things;

2 living things are bound together by many forces of nature. Many of these are cycles or chains which make living things *depend* on one another for survival.

One of these cycles is the food cycle. Many animals eat plants for food We call them *herbivores*. The elephant, the cow and the deer are common examples of these. Many insects like the silkworm and the butterfly also depend on plants for food. Now in the same way that herbivores depend on plants for food, *carnivores* or flesh-eating animals depend on animals for their food. Some of these animals on whom they depend are herbivores. For example a tiger eats a deer which in turn depends on leafy plants for its food. Thus the food chain is kept going.

Another chain or cycle is that of organic matter. We have read in Books 3 and 4 how the soil is made rich by organic matter mixing with it --decayed plants, and the bodies of dead animals. This soil helps new plants grow which are food to a large



part of the animal and human world.

It is chains like these which preserve the natural world. They also make it necessary for living things to fight for survival. Scientists call this a survival tendency or instinct.

THE BALANCE OF NATURE

As they studied the natural world, scientists found another strange fact—that there is a certain balance in nature. Plants and animals have remained more or less the same in number over thousands of years. You have just read that many animals eat plants for food, and many flesh-eating animals depend in turn on these herbivores for food. Thus, one way or other, all living things depend on plants for food. In spite of this plants survive, spread and have more or less kept the balance.

Sometimes this balance is upset by nature. Cyclones or severe turns of weather can destroy many plants. Sometimes men interfere in this. Millions of trees have been destroyed by their being cut down for timber. Similarly, some animals have become alarmingly small in number because they have been hunted for their flesh or hides or fur. Elephants have been killed for their tusks.

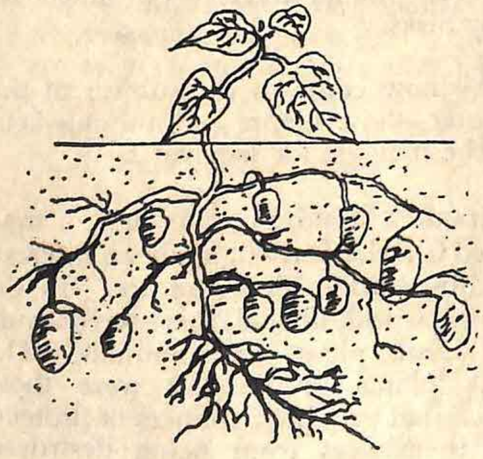
We now come to the subject of this chapter—how plants and animals keep up the struggle for survival.

About a hundred years ago, a man called Charles Darwin made an interesting observation about nature. In the natural world, he said, there were strong and weak plants and animals. The weak plants or animals were those which had very poor chances of protecting themselves from being destroyed or damaged by other things in their environment. On the whole, the stronger living things survived and spread over the Earth in large numbers. This is another reason why the instinct for survival and for protection is so strong.

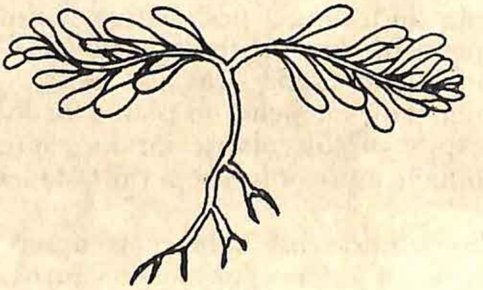
SURVIVAL AND ADAPTATION IN PLANTS

You already know the word 'survival'. The new word in the heading of this section is adaptation. Adaptation is the process by which plants or animals gain something in the way they look or behave so that they are protected against danger and against being destroyed. Let us look at adaptation or survival together because they are part of the instinct to live.

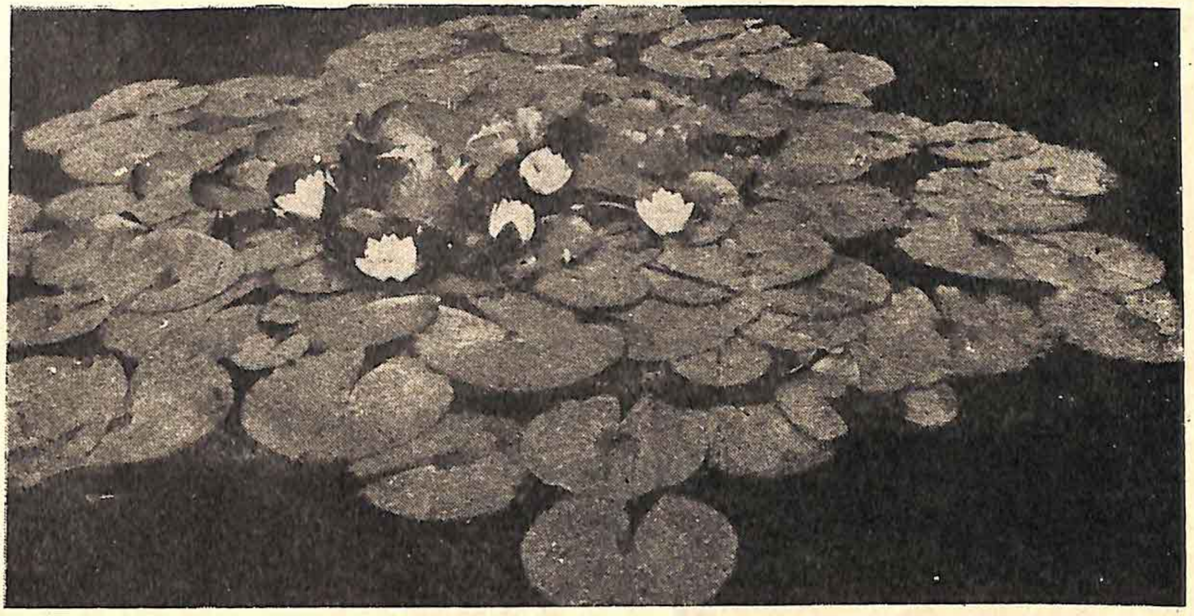
We have read in Book 4 about some animal and plant defences. Seeds, fruits and leaves may protect themselves by prickles or thorns. The cactus plant grows in desert conditions, where there is very little water. The water in the stems has to be preserved for as long as possible. A wound in the stem can cause the precious water to flow out. The leaves of the plant become sharp prickles to keep away grazing animals. The leaves of the casuarina plants are whirls of scaly leaves. This prevents them losing too much water in the hot weather. Some weeds spread themselves thickly over the ground and are difficult to destroy because even after you uproot them they take root again.



Adaptation helps the struggle for survival by providing means of storing water and food. Many plants growing in desert conditions have swollen stems or leaves to store water. Plants like the potato store food in their stems. Carrots are roots in which the plant has stored food.

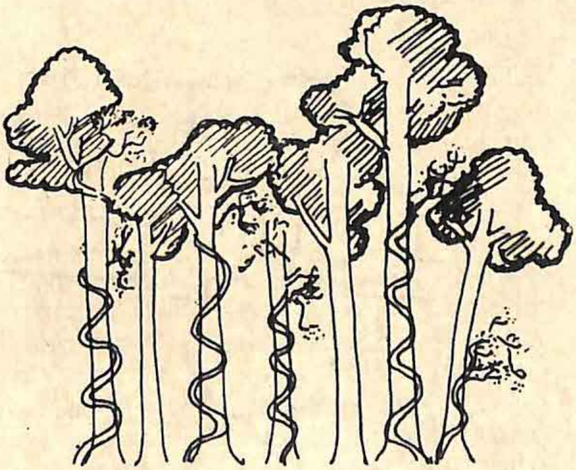


Water plants have to float to survive. The water lily is anchored to the floor

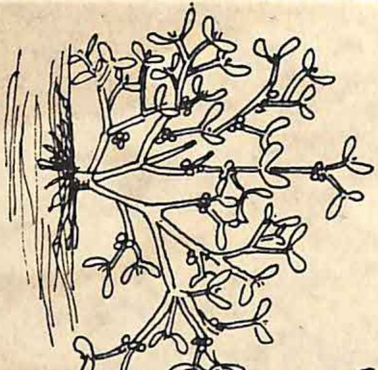


of the lake by its roots. The leaves are large and enable it to float on the surface. Plants like the water chestnut have air spaces. They are kept afloat by the air entering these spaces.

Here is the water-lily plant. The leaves spread out and keep the plant afloat. The leaves of some water plants are about a metre in diameter.

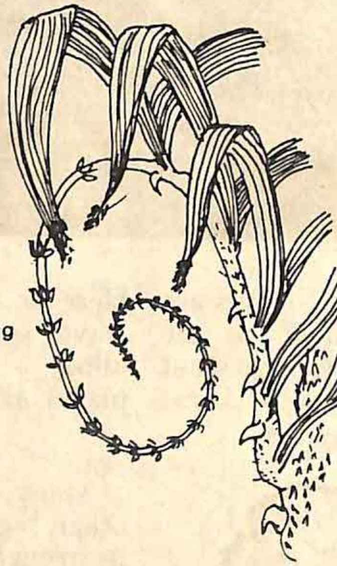


Many plants grow in the shade of other, bigger plants. These plants have to struggle to get as much light as they can. We see this happening particularly in dense tropical forests where large trees spread out over the shorter plants on the ground. Some plants adapt themselves by developing climbing habits. Climbing plants support themselves on the strong stems or trunks of other plants and climb upwards in search of air and light. In tropical rain forests, some climbing plants manage to climb to the top of the tallest trees.

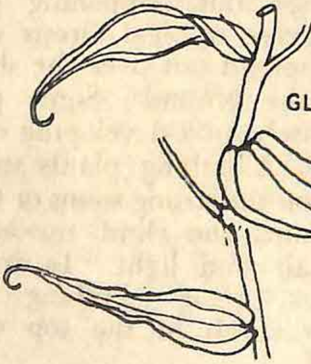


MISTLETOE: A Parasite

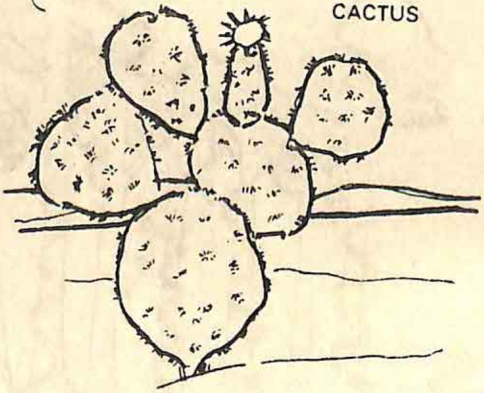
CASUARINA
Scaly leaves



RATTAN PALM
Part of leaf modified for climbing



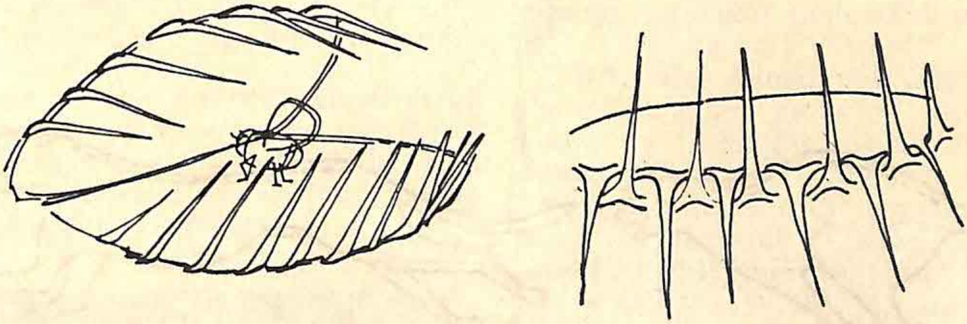
GLORIOSA



CACTUS

Many plants cannot make their own food or cannot make all they need. They draw food from other plants. Such plants are plant parasites. The mistletoe is a parasite. The seed germinates on the tree and its root goes straight into the branch of the plant. It also develops a growth called a sucker by which the seed and later the young plant cling to the host plant. Thin, hairy stems grow out of the sucker and draw food from the host.

Did you know that some plants use animals for food? Such plants are very few in number. Here are pictures of an insect-eating plant called the Venus Flytrap. The plant has beautiful leaves which attract insects to them. As soon as the insect settles on the open leaf, it closes shut and traps the insect inside. The insect is digested by the plant.

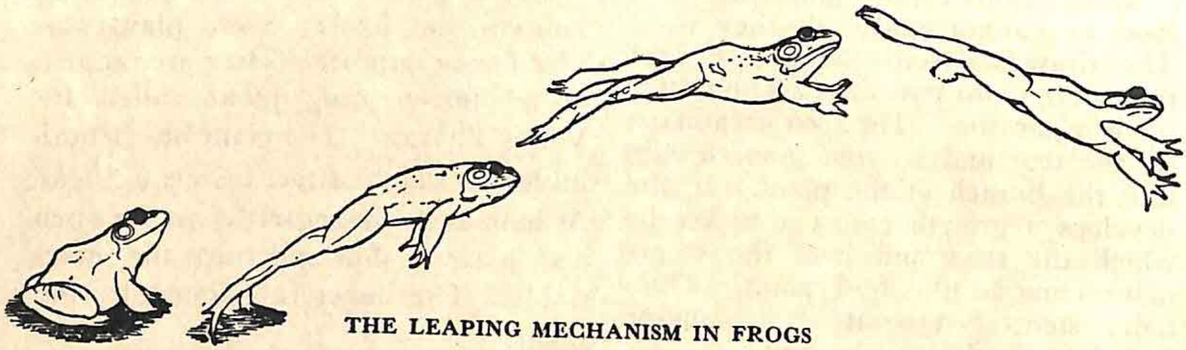


THE VENUS FLY-TRAP

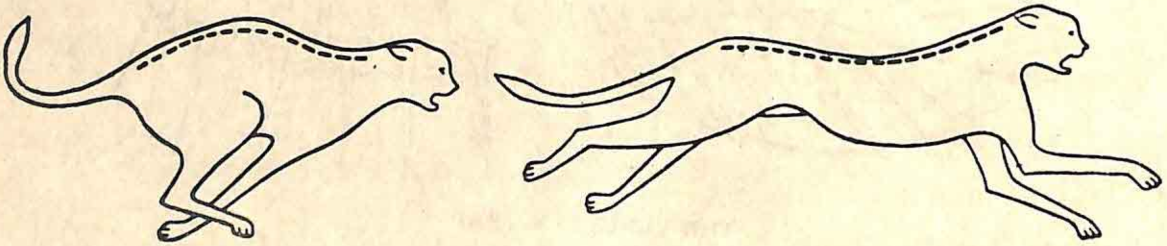
SURVIVAL IN ANIMALS

In Book 4 we have already read about some ways in which animals defend themselves against their enemies. They adapt features which improve their chances of survival.

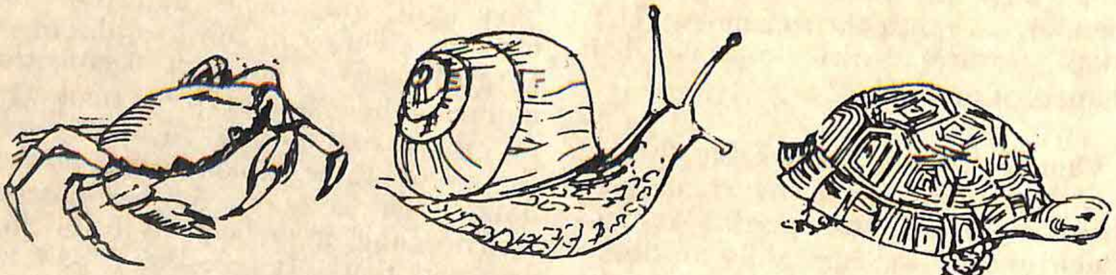
One of the most remarkable of these is escape from danger by running or flying away at great speed. Animals which move fast are able to do so because their bodies make this possible. Birds have beautiful, streamlined bodies. The bones are light and the body narrows towards the head and tail ends. Animals of the deer family also have light, long bones and powerful muscles. They can run long distances at great speed. In most fleet-footed animals, the external projections are very few so that the body shoots through the air or water without being slowed down. The body of a fish has muscles which enable it to bend its body this way and that. It has fins, a pair in front and one just behind the centre which keep it from toppling over or



THE LEAPING MECHANISM IN FROGS



THE FASTER ANIMALS

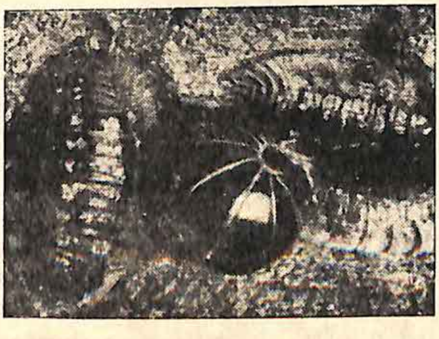


THE SLOW ANIMALS

rolling in the water. The tail and the long, smooth body are like oars which drive a fish forward.

The slower animals, which cannot escape danger by running away, have other ways of protecting themselves. Many of these have the protective, hard covering of a shell. They cannot be trampled on easily. Many kinds of crabs and lobsters have this 'armour'. The tortoise is another example of an animal protected by a hard casing. When danger threatens, it can withdraw its head and legs into the casing.

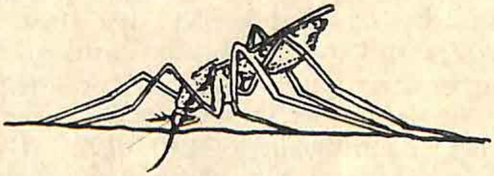
Some animals protect themselves by changing their shapes. The woodlouse rolls itself into a ball. Only the hard parts are exposed to take any knocks that danger might bring.



The camel is rightly called the ship of the desert. Its foot muscles and hooves are such that it can withstand long distances of walking in the sandy deserts. Its digestive system is built in such a way that it can store water.

Many animals survive and protect themselves by being openly aggressive. Snakes and crocodiles belong to this group. If they are threatened in any way they attack swiftly and some kinds can even kill a man in the process. Even their method of obtaining food for survival is based on attack and killing or paralysing. Tigers and other members of the cat family pursue their prey with great speed and for long hours. When they get near enough, they pounce on it and tear it with their teeth and claws. Many of you must have seen the eagle swoop down to grab a mouse or another animal in its talons.

There are animal parasites just as there are plant parasites. All of us know the mosquito which lives by drawing blood. Insects like mosquitoes and leeches feed on the host until they have had their fill. There are other animals which are (or can become) permanent parasites. Dogs have worms which feed on the walls of their stomachs and intestines. Sometimes these parasites are so strong and live on in this environment for so long that they become stronger than the host animal.



Special furs or thick skins are a protection against both severe winters and against harm. Blue whales have a layer of fat more than 40 cm deep (depending on their size) just under the skin.

An unusual way some animals have of protecting themselves is by looking like or imitating other animals which are feared. Many kinds of worms can be mistaken for the centipede. The hoverfly looks like a wasp and can be easily mistaken for one. But it has no sting and is perfectly harmless. It is able to protect itself by looking like a wasp!

We have already learnt about camouflage in Book. 4. The pictures on pages 75 and 76 will help you remember.

We have now learnt why survival is important. We have also learnt some interesting facts about survival and adaptation. Without this instinct to survive, the plant world would come slowly but surely to an end. Happily, we live in a world of plants and animals that struggle to live. Efforts are being made by us to preserve this state of matters and to help animals and plants protect their kind. There are now wildlife preservation societies all over the world teaching people to care. Earlier in this chapter we learnt about how men have interfered with and often upset the balance of nature. In now seeking to protect the world's flora and fauna, men are helping to put back the balance.

1 Why do most plants and animals have to struggle to survive?

2 What are the two cycles or chains you have just read about? Describe them in your own words. Can you think of any other cycles?

3 What do we understand by 'balance of nature'? What are the different elements that can upset this balance?

4 What are herbivores and carnivores? Name six animals in each category.

5 Among human beings, there are vegetarians and non-vegetarians, just as there are herbivores and carnivores in animals (some plants are carnivores, too). Is there an important difference between our tendency and the tendency of animals and plants?

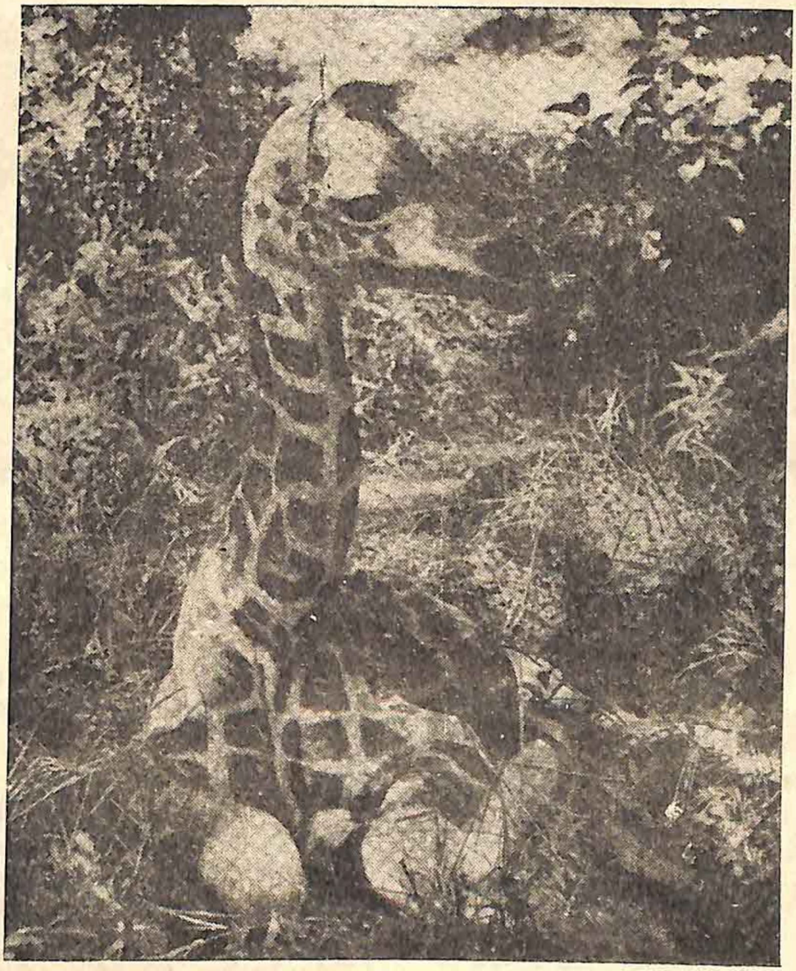
6 What features of adaptation do you see in the pictures on page 77? Describe each of them.

7 What is fur a protection against?

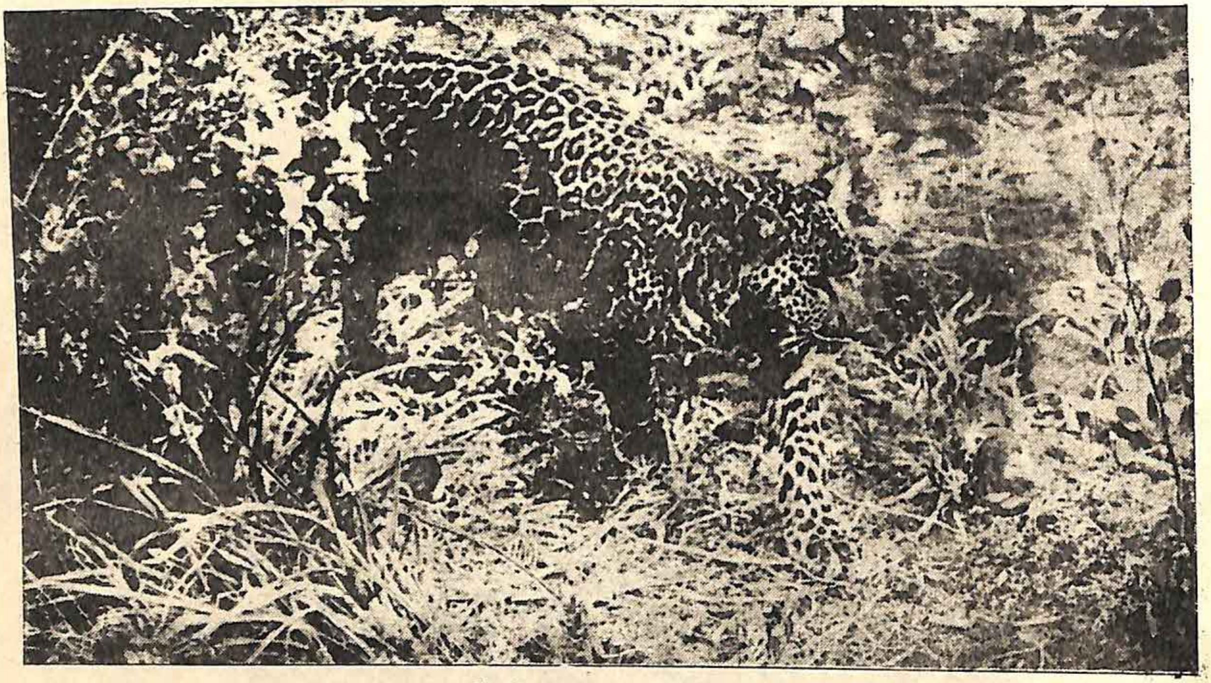
8 What features do you see in the slow-moving animals which you do not see in fast-moving ones? Make a list of these points as they occur to you.

9 What are parasites? Name two animal and two plant parasites, and describe how they live.

10 How have men interfered with the balance of nature and how are they trying to bring back this balance?



CAMOUFLAGE



CAMOUFLAGE

1 Find out how the following animals adapt themselves to their environment:

a) frog *b*) cockroach *c*) wasp

d) squirrel *e*) buffalo *f*) fox

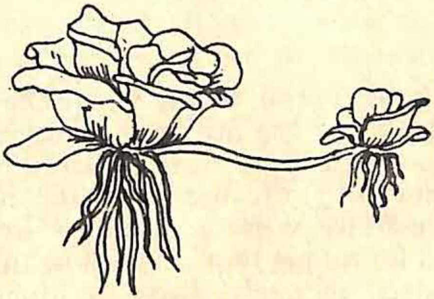
g) cat *h*) owl *i*) ladybird beetle

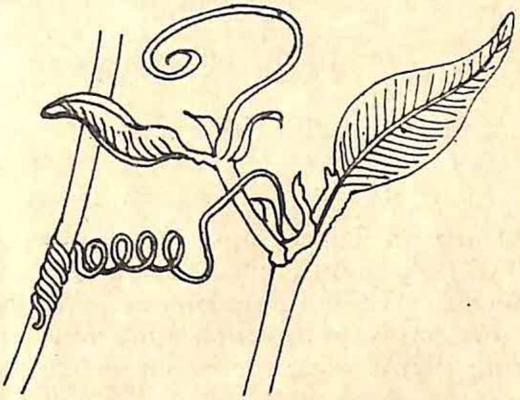
Think of special features, food habits, ways of movement etc.

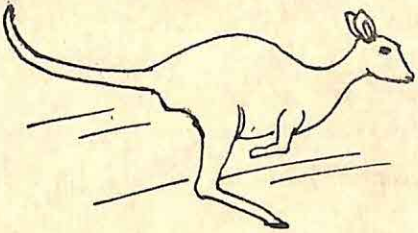
2 Make two charts for your classroom to show ways of survival in plants and animals. Think of your own labels for each column.

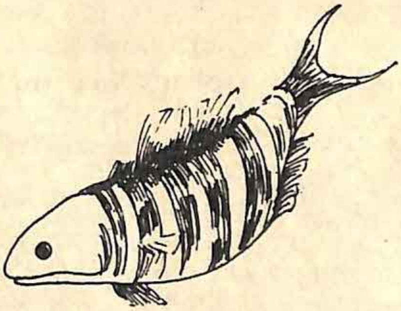
3 Have a classroom discussion on offence and defence in animals. First make a list of 10–15 animals that instinctively attack when danger threatens. Discuss in each case whether it is offence (attack in expectation of danger) or defence in the face of actual attack. You may come to the interesting conclusion that it is sometimes difficult to tell!

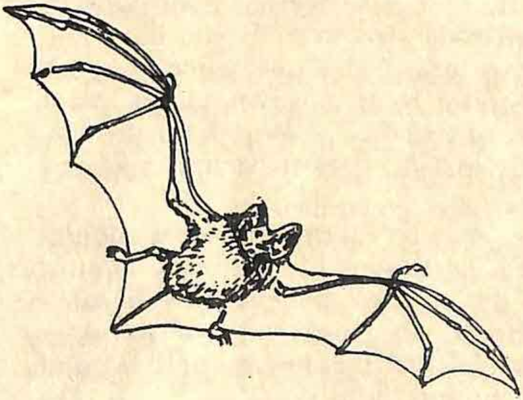
ADAPTATION IN ANIMALS AND PLANTS











7 SOME NON-FLOWERING PLANTS

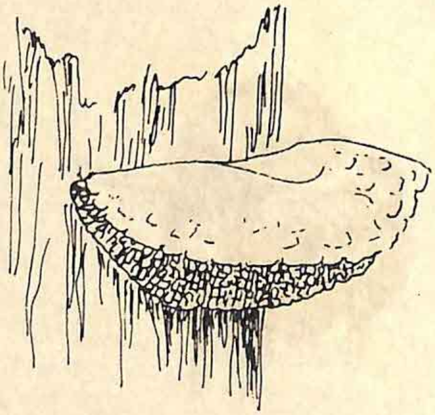
We learnt in Book 4 about how most of the world's plants make new plants from seeds. We will now look at some of the unusual ways in which some non-flowering plants make new plants (we will use the word *reproduce*). We will also look at the structures of these plants—fungi, algae, mosses and ferns.

Non-flowering plants like the moss and fungus (plural, fungi) do not, for a start, look like the ordinary plants we see around us everyday. Because of this and also because they do not produce fruits or seeds, scientists were puzzled for a long time about how they reproduced themselves and multiplied so rapidly. The microscope, especially the more powerful ones we have today, has made it possible for us to examine these in great detail.

FUNGI

Have you ever opened the box in which you keep your loaf of bread to find that it is covered over with a greyish-blue growth? If you have not, you can 'grow' this on a slice of bread by keeping it in a warm, damp place for one or two days. Watch the growth. Does it spread, does it become thicker?

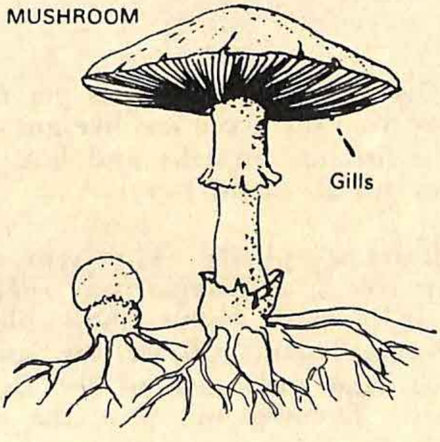
The growth on the bread is mould, a kind of fungus. Fungi are plants. It is difficult to believe this because moulds do not have roots or stems or leaves. Neither does yeast, another plant of the fungus family.



Each of these plants is neither male nor female. Moulds consist of groups of cells which are thread-like in structure and tangled together. They carry spores. As the spores develop, they burst through the case in which they are contained. They are so light that they fly freely through the air till they can settle on some organic substance. Once settled, a spore multiplies rapidly by feeding on the organic matter and using the nutrition to make cells. These cells once again form thread-like chains and the process of reproducing begins all over again.

Fungi are of many kinds. A mushroom is really a kind of large fungus. They look like mould if you look at them underground, but the cell-threads above the ground weave themselves into tight masses.

Mushrooms develop a peculiar umbrella shape. Under the roof of this umbrella you can see layers arranged like a closed fan. These are gills. The gills produce thousands of tiny spores which are hidden in their folds. As in moulds, the spores are carried away by the wind and can grow into new mushroom plants.



Yeast is another kind of fungus. We use yeast to help the bread-dough rise as it bakes. Men have used yeast fungus for hundreds of years to make wines, spirits, beer and to bake breads. The yeast plant is a single-celled plant. It grows 'buds' which develop into new cells and form a kind of chain. When the new cells have grown fully they move away from the mother cell and are now yeast plants in their own right. This kind of reproduction is called vegetative reproduction.

Fungi, as we have just seen, are of many kinds. Some are parasites which destroy or infect living things. Many kinds of fungi are regarded as plant pests. Farmers constantly face the problem of getting rid of these and protecting their crops. Some other kinds of fungi destroy wood. Ringworm, a disease which infects human beings, is a fungus growth.

Some species of fungi have been very useful to us. Scientists have learnt to use many of them to make drugs that can fight diseases. They do this by feeding on the organisms that cause this disease. We will learn in a later chapter how a great scientist called Alexander Fleming discovered a fungus which he used to make one of the world's most important drugs—penicillin.

ALGAE

Algae (singular, alga) look much more like ordinary plants than fungi do, mainly because they are green or greenish. You see them floating around in tangles in lakes, ponds and seas.

They have no parts resembling or doing the work of leaves, stems or roots. Seaweed belongs to the family of algae.

Most kinds of seaweed have flat, leafy structures bunched together. These are called fronds. The fronds can cling to rock or to land surfaces by means of growths on their surfaces called holdfasts.

An alga may be male or female. It reproduces from eggs. The fronds of the female plant have pits on their swollen ends which carry these eggs. The male plant carries sperms in the same way. When the sea-tide is out, the eggs and sperms are pushed out of the pits. They float around in the water again when the tide comes in. When an egg and sperm come together, the egg is fertilised. It now develops into a new plant by multiplying its cells rapidly.

Until recently, algae were regarded as 'nuisance' plants. They could clog the surfaces of whole ponds. In looking for new sources of food, scientists have found that a lot of nutritious substances can be extracted from seaweed and other algae. They may, in the future, become an important source of food when others are getting slowly reduced.

MOSSES

Mosses are a kind of plant that grow on damp surfaces. They are brilliant green in colour and can cover a wall like a carpet.

Mosses look more like ordinary plants than most other non-flowering plants. They have hairy tips which look like roots and which also do the work of roots. They attach themselves to the surfaces of walls or the ground and draw in salts and water. Mosses get their colour from the green leaf-like growths. The stems are straight and bear the leaves in tufts at the top.

Mosses are plants. They reproduce themselves in an unusual way. There are male and female moss plants. The male plants release the sperms which float on water to the female plants. These plants carry the eggs, and the sperms fertilise the eggs. You can see how mosses depend on water to reproduce themselves although they are land plants.

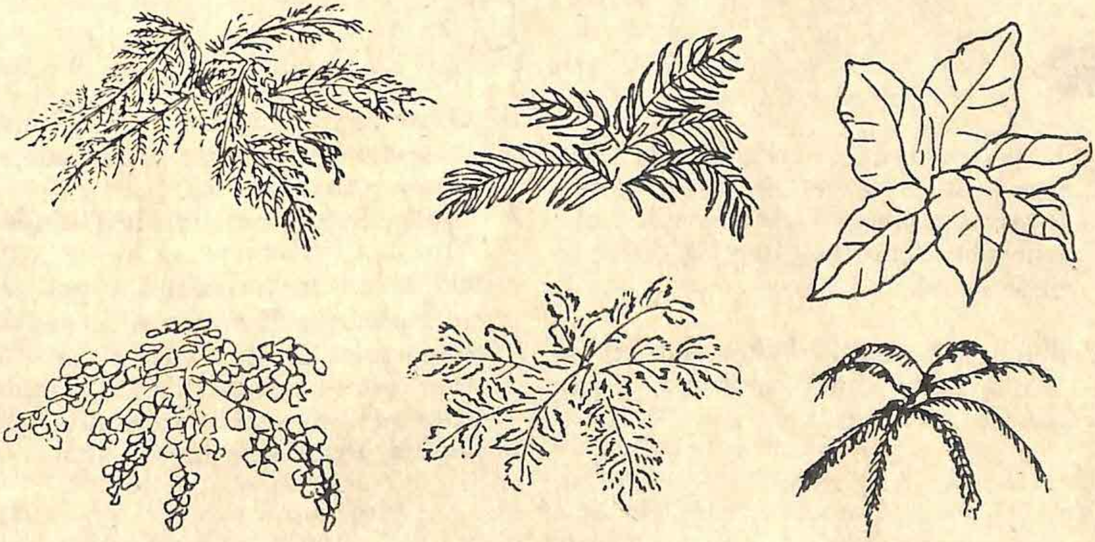
The new plant that now grows from the egg does not look like the parent plants. It is a parasite and attaches itself to the female plant until it is fully grown. This plant has a swelling at the end of a slender stalk. You can see this if you look closely at the walls. It produces spores which are carried away in the breeze and take root on a new damp surface. The plant that grows from this is a male or female plant once again. The moss thus has alternative generations of plants.

You may have seen gardeners packing support for climbing plants with moss or mixing mossy soil into the soil in flower pots. This is because mosses, being plants, are organic matter. When the plants have reproduced, they decay slowly and fall off walls or mix with the soil they cover. They thus make the soil rich. Mosses have been found very useful for this purpose. They are part of nature's cycle of organic matter—we read about this in Chapter 6.

FERNS

Ferns are beautiful land plants. They usually grow in damp places where the temperatures range from cool to cold.

Ferns are like mosses in the way they reproduce themselves. The difference is that the spore-bearing fern is also much



bigger than the egg or sperm-producing plant.

Ferns are very leafy. The leaves grow along a straight stem. The leaf blades are of many sizes and shades of green. The cuts in the edges result in beautiful shapes.

Look at the leaf of a fern closely the next time you see one. On the underside of the leaf you find a number of brownish-green balls sticking to it. These contain the spores. Each spore has a male and female plant. When the male part releases the sperm, it floats in water to the female part which contains the eggs. The eggs are thus fertilised and a new plant is produced. This plant looks like the spore-bearing fern except that it does not have spores in the beginning. It produces them later, and the process of reproduction begins again.

1 How are non-flowering plants like fungi and mosses different from flowering plants? Make a list of common features, then a list of differences.

2 What are fungi? Where are they found and what conditions help them grow?

3 Are fungi useful or harmful to the living world of plants, animals and men?

4 How do moulds develop?

5 What are algae? How do they reproduce themselves?

6 Describe a moss plant. In what unusual way do mosses reproduce themselves?

7 How do mosses help the soil or organic cycle?

8 In what ways are ferns different from the other non-flowering plants discussed in this chapter?

9 Write a note on how ferns reproduce themselves.

1 Grow mould on bread. Examine it under a powerful microscope. Draw what you see.

2 Make sketches of fern-leaf blades. You can look them up in an encyclopaedia if you cannot get the real plants. If you can, draw the undersides of the leaves, showing the spore-cases sticking to them. Remove a spore carefully and look at it under a microscope.

8 OUR BODIES: BONES, MUSCLES AND NERVES

Your body is one of the most remarkable machines you can find. It is capable of doing amazing feats. It can adapt itself to different kinds of difficult weathers. It can bend, stretch, twist, roll and leap. It warns you of approaching danger. One of the most wonderful features (which other living things do not have or have to a far lesser extent) is the ability to think and create things.

All this is made possible by a number of things in the body working together. We call them systems because it is really groups of organs or bones or muscles or nerves which work together. In this chapter, we will look at these systems of bones, muscles and nerves.

OUR BONY FRAMEWORK

On page 84 is a picture of a skeleton. Your body would look like this if you removed all the skin, flesh, muscles and organs from it.

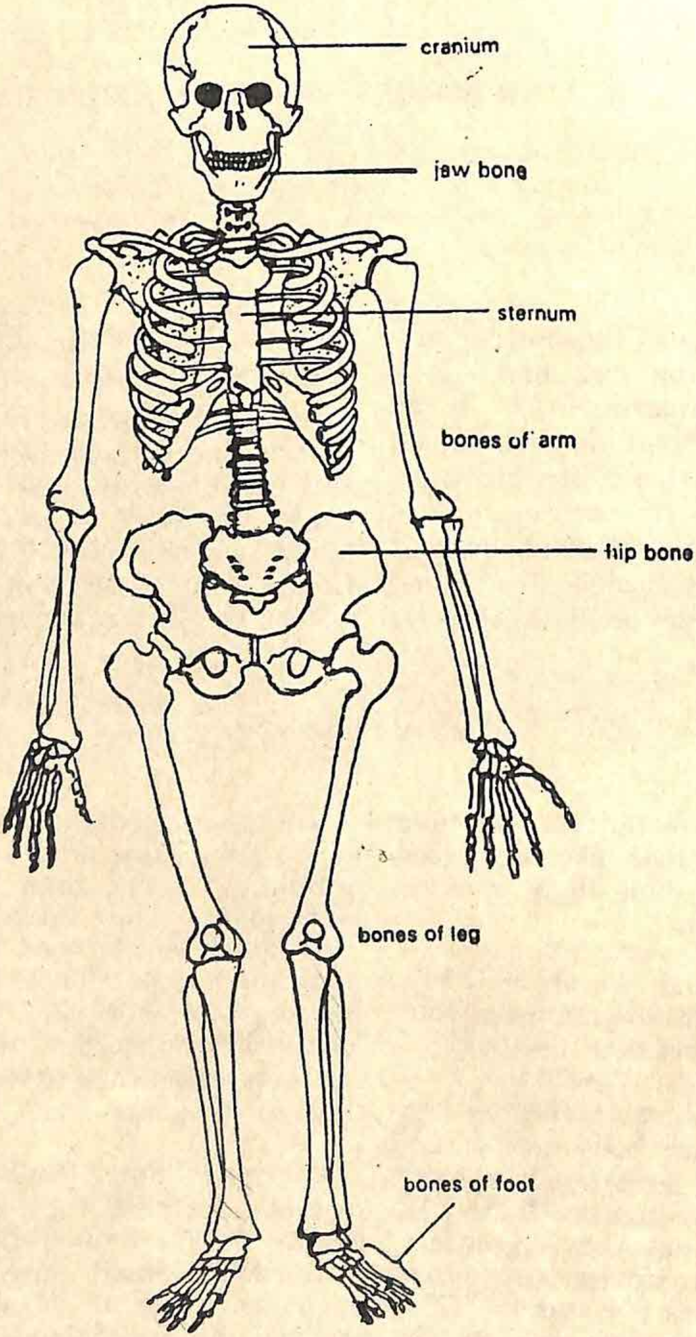
Bones are the hard parts of your body. You can feel them if you press your finger or feel all over your knee.

Bones give our bodies a firm frame. Without them our body would not have a shape. It would sag or hang limp with the skin in loose folds. In the same way, bones also support us. They keep the body upright and help it from bending unless it wants to. The framework of bones also protects the delicate organs of the body.

The group of bones have a strange job to do. They must keep the body upright. Yet they must also make the body move. How does this happen? The bones which need to move the body have joints. These make it possible for it to move in different ways. You will read later in this chapter how the muscles attached to the bones move them at the joints.

We have more than two hundred separate bones in our bodies. Some, like the skull, are fused together. That is, the two or more parts have joined to make a whole. Others are not attached, but they come together when movement is needed.

THE HUMAN SKELETON



When you were a baby, your skeleton was a softer, more bendable thing. The substance is called cartilage. This changes into hard bone as the body grows. While you are still a baby, your bones are like plastic and their shape can be changed fairly easily. This is why it is important to make sure that your body keeps its shape while you are still young. Later, when the bones are harder, it is difficult to change this.

Young children's bones can bend very easily. They do not snap as easily as the older person's bones can. This is because when you are a child, your bones are made of organic matter like cartilage. As you grow, your bones lose more and more of this organic matter and get rich in mineral matter. This makes them harder and stronger, but they can also be more easily broken.

Look at the skeleton on page 84 again. The bony hardness in your head comes from the cranium. A set of bones have fused together to form the cranium. The part of your head that *can* move is the lower jaw which works on a set of joints. Your neck and back are supported by the vertebral column which is like a long tail of bones down your neck. Your neck turns again on a set of joints. The sternum or breastbone holds the rib-cage together. The ribs are curved bones which are joined in front to the breastbone or sternum, and at the back to the backbone. The rib-cage protects the heart and lungs, two of our most important organs.

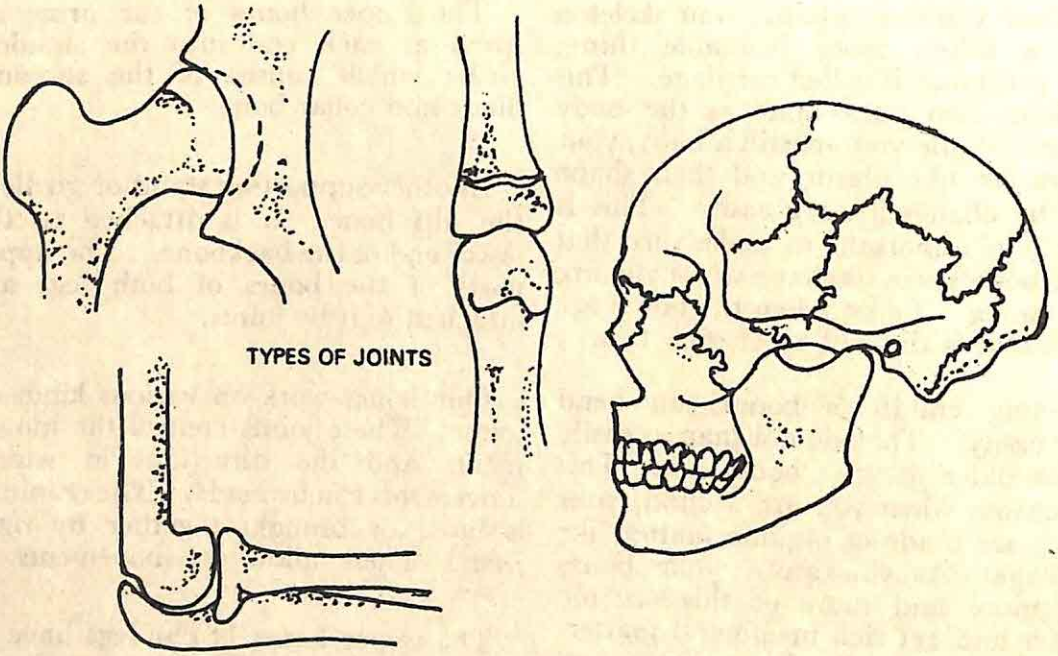
The upper bones of the arms are fitted at each end into the shoulder girdle which consist of the shoulder blade and collar bone.

Another supporting stand or girdle is the hip bone. It is attached to the lower end of the backbone. The upper parts of the bones of both legs are attached to it by joints.

Our bones work on various kinds of joints. These joints control the movements and the directions in which movements can be made. The cranium is fused or brought together by *rigid joints*. These allow no movements.

The upper bones of our legs have a round ball-like knob of bone. These fit into a cup-shaped curve of the hip bone on either side. The ball can move freely within the cup and they allow the leg to move freely in all directions. This kind of joint is called the *ball-and-socket joint*. Our arms also swing on a set of ball-and-socket joints. You can understand how this works if you make a 'cup' with one of your hands, and a ball with the fist of your other hand. Fit the fist into the cup of the other hand and move it in a grinding motion. Can you see how freely the fist-hand moves?

Our elbows have *hinge joints*. The bones are arranged in such a way that only backward and forward movements are possible.



TYPES OF JOINTS

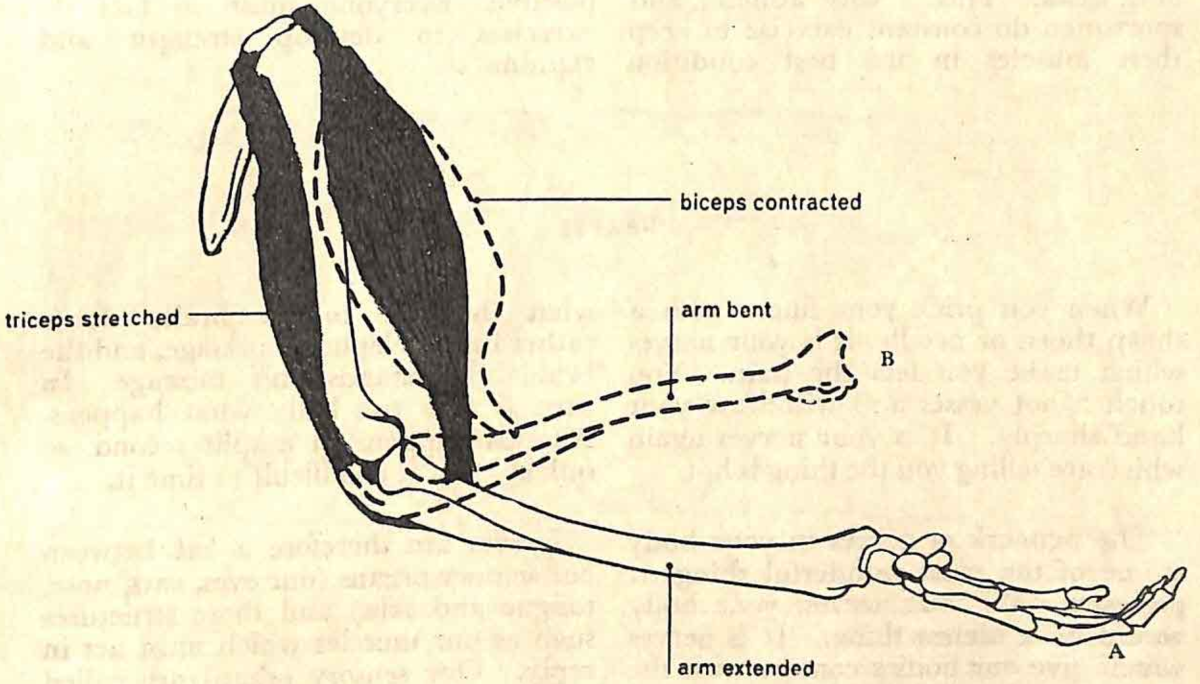
MUSCLES

Your body can move because of the groups of muscles which move the joints. Without muscles, the body would be dangling at its joints without control on the force or direction of the movements, rather like a puppet.

Muscles are made up of parallel rows of fibres packed together. They are attached to bones by tendons. Tendons have to have a plastic quality. They must be able to withstand a great deal of stretching. You can feel the tendon in your upper-arm muscle (called the *biceps* muscle) if you feel just above the inside of your elbow joint as you bend your arm up and down.

You can feel the remarkable muscles in your body. When you chew, your jawbone muscles are working. When you bend your arm at the elbow, your biceps muscle pushes out and bulges. When you move your foot up and down without moving your leg, another remarkable group of muscles is working. The weight-lifter uses his powerful arm muscles to keep the weight lifted.

A muscle works by what is called stretching and *contraction*. When it is not in use it is like a soft mass and is long. When it is made to act, it contracts. This means that it pulls in and becomes tighter, shorter and fatter.



The muscle pulls at the bone through the tendon to which it is attached.

Muscles in important parts of our bodies usually work in pairs. These pairs work in opposite directions. Hold your hands together as shown in the picture. Move both in a rubbing motion in opposite directions to make a longer 'line'. The muscles of your arm work like this. Look at these diagrams of the muscles as they appear when your arm is open (A) and bent in (B). The biceps muscle stretches in A, whereas the muscle at the back contracts and makes a hard bulge. In B, when the hand is bent, the opposite happens.

Muscles can be divided into two groups according to whether or not we can control them. Some muscles are under our control and we can get them to move as we like. The muscles in our arms, legs and mouth are examples of these. There are other muscles which we usually cannot control. These may be in organs like the heart or walls of the food canal. Here the muscles do their own special kinds of work.

Muscles have to be used and exercised for them to be strong and able to take great lifting and straining loads. Without exercise they can become flabby and weak. This is why athletes and sportsmen do constant exercise to keep their muscles in the best condition possible. Everyone must in fact do exercises to develop strength and stamina.

NERVES

When you prick your finger with a sharp thorn or needle, it is your nerves which make you feel the pain. You touch a hot vessel and withdraw your hand sharply. It is your nerves again which are telling you the thing is hot.

The network of nerves in your body is one of the most wonderful things it possesses. Without nerves, your body would be a lifeless thing. It is nerves which give our bodies contact with the outside world. They make it possible for us to see, hear, touch, taste and feel. We will see later how another set of nerves causes us to do things to understand how we sense the outside world through our nerves. Let us look at one of the ways of feeling—touch, pressure and pain.

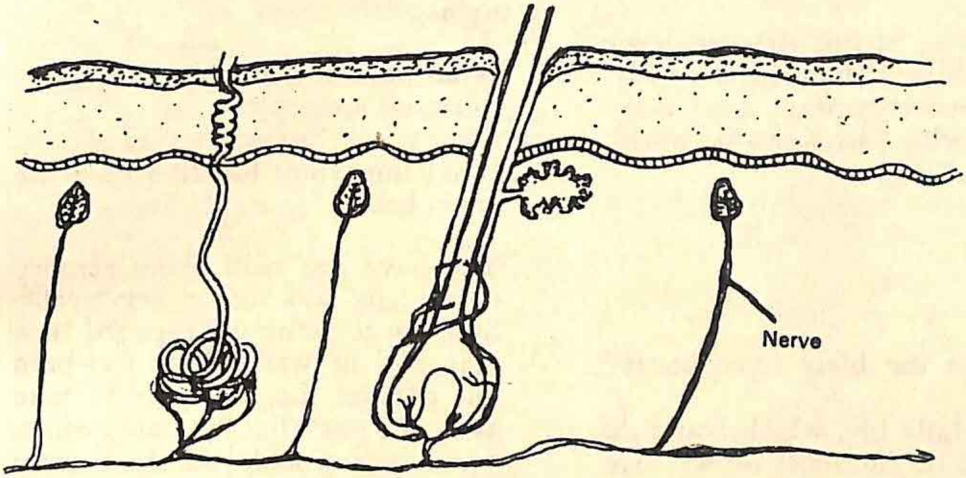
Look at the diagram on page 89 of a cross section of your skin magnified several times. You can see the nerve fibres set close together. They are connected to a cross fibre. When you touch your hand or press on it, it is these nerve-endings which take the 'message' to the commanding captain of your body, your brain. Similarly your eyes have nerve-endings just below the surface of the eye. These nerves convey the message about what they see to the brain. It is rather like a telephone message, and the brain understands this message. In turn it tells the body what happens. All this happens in a split second, so quickly that it is difficult to time it.

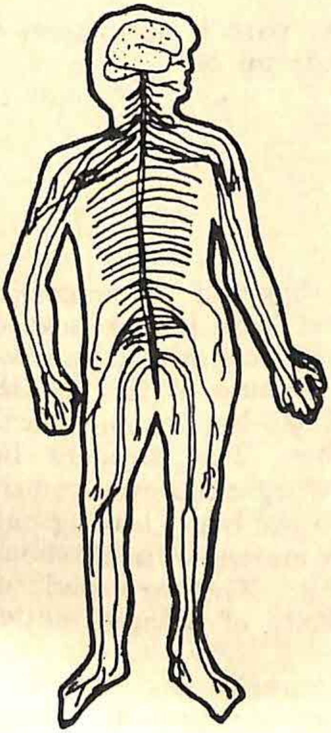
Nerves are therefore *a link* between our sensory organs (our eyes, ears, nose, tongue and skin) and those structures such as our muscles which must act in reply. Our sensory organs are called *receptors*. Nerves link these through the brain to the *effectors* or the doers such as our muscles and glands.

Our nerves are not built to control the action we take or the things we feel. They are wonderful messengers or carriers. To turn these into a force which will make us act in a controlled way, we have two wonderful systems—the brain and the spinal cord.

The *brain* is like a giant switchboard. It is protected by the bony skull and is made up of many millions of nerve cells. When the nerve fibres bring in messages from the receptors, the brain cells receive these and then makes fresh messages to the effectors to act. Thus if you touch a hot flame, a message

SECTION THROUGH SKIN





about the hotness is conveyed to the brain. In turn the brain instructs the muscles of your hand to pull your hand away. The *spinal cord:* Another wonderful system of nerves is housed inside your backbone. This is your spinal cord. It is connected to the brain at the top end and runs down along the length of your back. The spinal cord links the brain with some parts of our body. It is responsible for some of the simple actions of the body.

There are two kinds of nerve cells or neurons. One is the sensory neuron which conveys messages of what we know through our sensory organs. The other is the motor neuron which sets off the message asking the effectors to act in a certain way.

We have seen, in this chapter, some of the remarkable systems in the body. They make the body work. They make us creatures who can feel the world, enjoy it and react to it.

1 Why does the body have bones?

2 In your daily life, which bones do you think do the most work? Are they built to adapt to this work?

3 How is movement made possible?

4 What are the kinds of joints about which you have just read? Why do you think the body needs different kinds of joints?

5 What are muscles and why do we need them?

6 How do the muscles and bones work together? What purpose do the tendons serve?

7 Why does your biceps muscle bulge when you bend your hand at the elbow and make your fist into a tight ball?

8 How do pairs of muscles act?

9 What are the two different kinds of muscles?

10 Which muscles do we normally use every day? Are there any that we neglect?

11 What work do nerves do? Explain this with examples.

12 What important function does the brain have?

13 You have just read about sensory nerve-cells and motor nerve-cells. Suppose something happened to a man and he was able to feel pain but not act (i.e. not able to take away the part that felt pain) which nerve cells would you think were damaged—the sensory ones or the motor ones?

14 What three parts is our system of nerves made up of?

1 Take the bone of an uncooked chicken and leave it in a bowl of vinegar for a few days. You will find that because of this soaking the hard bone has become plastic and flexible. This happens because the vinegar has dissolved the minerals in the bone, leaving only the organic matter. A baby's bones are like this. They are made up almost wholly of organic matter.

2 Feel the muscles and bones in various parts of your body. Make

lists of joints with which only one kind of movement is possible and those which allow many kinds of movements.

3 In which parts of your body do you feel your muscles pull when you

   a) stretch your hand to point at something?

   b) clutch an object tight in your hand?

   c) hang on to a bar?

   d) try to reach something on the floor with the tip of your leg?

4 Which muscles in your body can you pull in?

9 MAN AGAINST DISEASE

Disease and sickness are not new in our world. Men must have known both ever since they first appeared on earth. In those times, disease must have been a much more frightening thing than it is today, when we have medicines and drugs to fight it. Imagine the fear of a man who finds that people around him are dying or stricken with an incurable disease. It is spreading and it is only a matter of time before he will die too.

The worry about finding medicines to cure diseases is also an old one. For thousands of years, men tried to make medicines from plants and from animal matter. In Egypt and India, the science of medicine made great progress and people were able to cure some diseases, and to perform simple surgical operations.

But the world is not free from disease and sickness. There are many 'catching' or infectious diseases which spread easily from man to man. The common cold is one of these, 'flu or influenza is another. There are other, more serious diseases like malaria, typhoid fever and tuberculosis (commonly called TB). For hundreds of years the more serious diseases caused helpless deaths. No one knew or was able to find out where they came from.

Today we know that disease is carried by tiny, invisible organisms. The common name for them is germs. Although scientists suspected that some kinds of living things cause disease, they could not see these organisms. When the microscope was invented about 300 years ago, it became possible for them to actually see these.

More than 300 years ago, an Italian scientist called Redi found the eggs of fly maggots in a piece of rotten meat. He examined this closely and found that the maggots did not come *from* the meat, but were hatched from eggs laid by flies on the meat. He was able to show that living organisms are constantly feeding on other organic matter. He suspected that these organisms carried the disease germs.

About 50 years later, when the microscope was invented, a Dutch scientist called Leeuwenhoek was able to see these tiny, living carriers of disease. He found that they reproduce themselves easily, and could grow and spread in large numbers.

About a hundred years ago, a French scientist called Pasteur made one of the most important discoveries in the world of medicine. He found even smaller organisms than Leeuwenhoek and he called them bacteria. He found that bacteria (singular: bacterium) carry disease. Not only this, each disease has a different type of bacteria.

Pasteur proved this by being able to get pure collections of the bacteria causing cholera, a dreadful disease. A healthy living thing, he said, can catch the disease if the bacteria find a home in its body. He could not, of course, try experiments on people, so he used animals. He injected a liquid containing the cholera bacteria into healthy chickens. The chickens got cholera and died. They were *infected* by the cholera germs.

Pasteur's discovery helped people to understand how the disease was caused. Like a true scientist, he then began to find out how people could be prevented from catching the disease. One of his experiments was to *weaken* the cholera-germ fluid. He then injected it into a set of healthy chickens. They showed mild signs of cholera but none of them died. When they were all right, Pasteur injected the strong cholera-germ fluid into them. We have seen in the experiment described earlier, how the chickens died of cholera. But these chickens did not die. Here is a simple explanation of this:

Our bodies are always waging quiet battles against small infections. Every time there is an infection, organisms called antibodies fight against the disease-carrying bacteria and try to kill them. When Pasteur injected the weak cholera-germs, it was as if he was sending a few enemies to warn the antibodies that more were to follow. It was like a signal to the antibodies to prepare themselves and to increase their numbers to be able to fight a bigger group of enemies. By the time the chickens had become well again, the antibodies had increased and were now prepared to fight a larger enemy. This larger enemy came when Pasteur injected the strong germ-fluid. The enemy was killed because there were now enough antibodies to put an end to it.

The explanation is, of course, not as simple as this. But Pasteur had made one more important discovery—that if the body gets a weaker form of the real disease, it could fight the disease when it came.

Another scientist called Jenner added to this knowledge. In his time, and in the place where he lived, a rash called cowpox was very common among milkmaids. It was an infection got from the cow. At that time, a dreadful disease called smallpox was spreading. Jenner made a strange discovery. He found that people infected with cowpox did not get smallpox. He came to the same answer as Pasteur did about infection and antibodies. The cowpox made the women *immune* to smallpox.

Here is a statue of Jenner proving his point. He caused a child to get cowpox by making scratches on his skin and transferring the cowpox germs on to them with a needle. The boy developed cowpox rash. Jenner then injected smallpox bacteria. Fortunately, the boy did not catch the disease.

Koch, another scientist, made many important discoveries. He and Pasteur found and grew colonies (or cultures) of bacteria causing various kinds of diseases. In infectious diseases, the germs of that disease get into the body. They multiply quickly and spread. They feed on the body tissue and live on it like parasites.

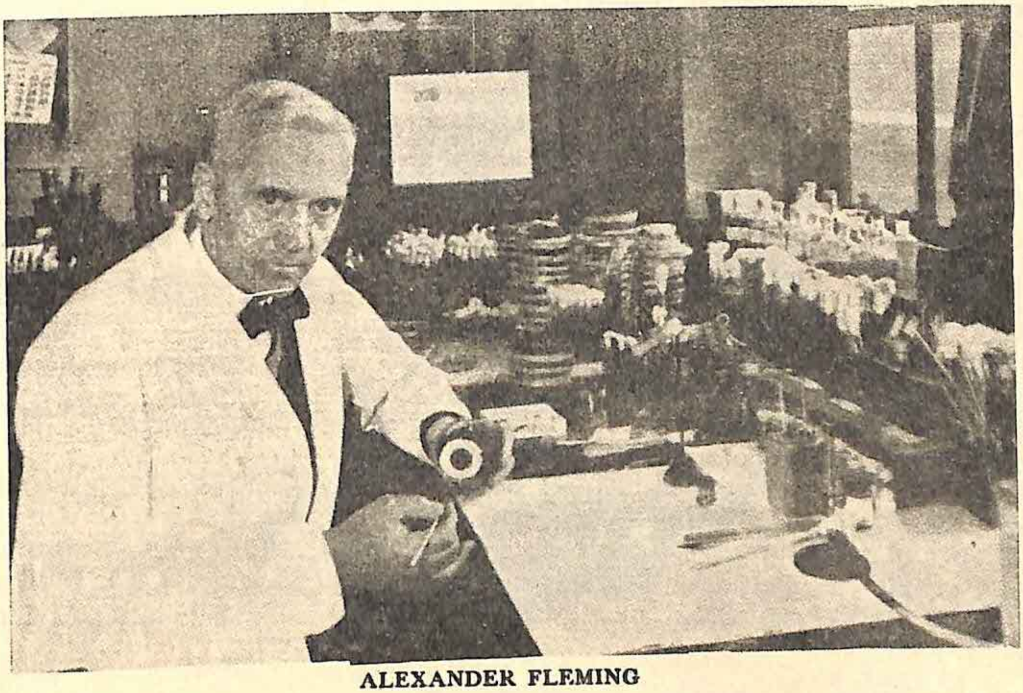
We can now understand what vaccines are and how they work. A vaccine is a weak bacteria culture of a particular disease, say polio. It is put into the body to make the body develop antibodies to fight the real disease when it strikes. All over the world the war is on against infectious diseases. This war is a difficult one. People must be protected against the disease. The treatment must cure the patient and not harm him in any way.

JENNER

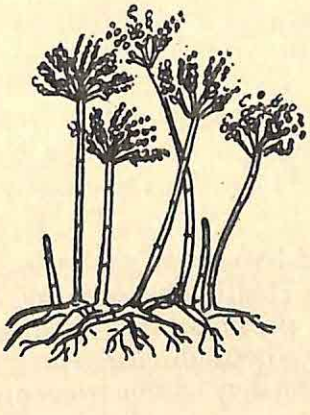
DRUGS

We read in Chapter 7 about moulds which are non-flowering plants. About 50 years ago, a scientist called Alexander Fleming was studying different kinds of bacteria through his microscope. One day he made a surprising discovery. A mould had grown on one of the dishes in which he had left a culture of bacteria. What was more, the mould was slowly killing off the bacteria in the dish! This was the discovery of penicillin, one of the most wonderful of drugs today. It is a drug made from a mould called penicillium which destroys particular types of bacteria. Several drugs are made from it and it can cure many kinds of infections.

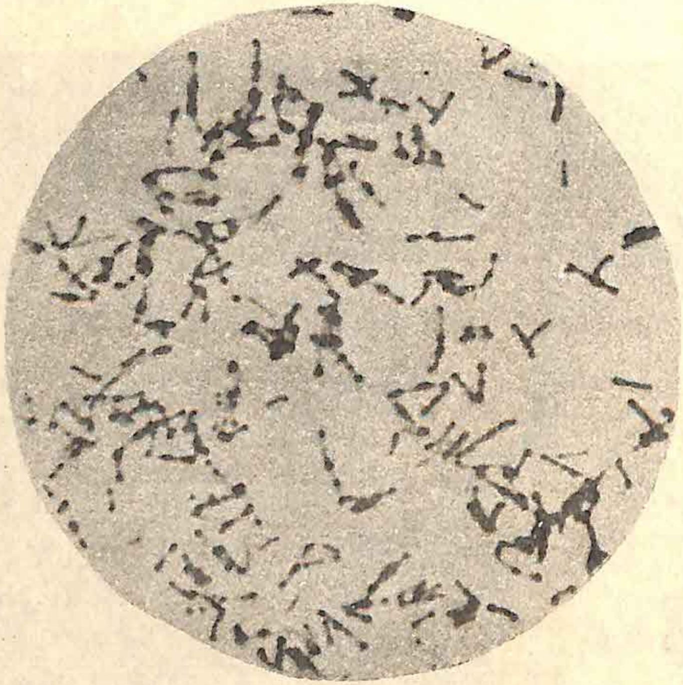
Since then a number of other drugs have been discovered. They are called antibiotics.



ALEXANDER FLEMING



The picture above shows you Alexander Fleming in his laboratory. His discovery of penicillin created history. It had great healing properties because the penicillium mould would destroy the bacteria and thus help the body recover slowly. Diseases like tuberculosis have been cured with penicillin. Before its discovery, tuberculosis almost meant death. On the left are the penicillin moulds as seen through a microscope.



Here is a picture of diphtheria bacteria seen through a microscope. Look at the rod-like shapes.

HEALTH FOR EVERY MAN

Every man, woman and child has a right to perfect health. The discoveries of vaccines and drugs has made it possible for us to fight diseases in a big way.

World-wide organisations like the World Heath Organisation have large health programmes. People are being taught about diseases, how they occur and how they can be prevented. It was because of such a programme that smallpox is now an unknown disease. Less than 15 years ago, it was a great killer.

Health really begins at home. It begins with cleanliness — clean air, surroundings, water and a healthy food diet.

Clean air: Many bacteria and other germs travel through the air. Good ventilation and fresh air are more important than we realise, and we must try to make sure of these wherever we live or work or sleep.

Water: Water is an important source of infection. This is very true of water obtained from shallow wells. In most large towns the water supply is filtered and cleaned to some extent by treating it with chemicals. But this is not true of villages and many small towns.

An infected, unprotected water supply is one of the greatest dangers possible. Water carries disease parasites just as air does. Water must be filtered and boiled for drinking and cooking.

Disposing of waste and refuse: The problem of where men can throw waste matter and rubbish is a big one. Waste matter, especially the organic waste matter from our bodies is an ideal ground for disease-carrying bacteria. In India, flies and cockroaches have been able to breed in large numbers because of this. In every town and village, we are trying to have healthier surroundings. Arrangements are made by the municipality for regularly cleaning the streets and carrying away refuse. The sewage systems are being improved.

FOOD AND NUTRITION

We are dealing with food separately here because it is linked with health in two important ways: 1) good food means good health and 2) food carries infection if we are not careful about cleaning it or cooking it in the right way before we eat it.

In Books 3 and 4 we looked at food and its values. From food we get proteins, carbohydrates, fats, minerals and vitamins. We need these throughout our lives, some in greater quantities than the rest. Everyone needs food and we need same kinds of nutrients but in different amounts. A diet that is healthy for one may not be very healthy for another.

The following groups of food should be a part of every healthy diet:

1 Milk and milk products
2 Fruits and vegetables
3 Cereals and bread or chapatis

4 Fats

5 Meat (or vegetable sources of protein)

Milk contains some of the most essential nutrients, and should be a part of our daily diets.

Fruits and vegetables contain water and a substance called cellulose. Many vegetables are rich in vitamins and greens like spinach are rich in iron. The best way to eat most fruit is to eat them raw. The healthy way to eat vegetables is to steam them or boil them partly. Overboiling can kill the nutrients, so can frying in oil.

Cereals and bread are energy foods. They are rich in carbohydrates, many in protein. But they must be eaten in limited quantities because they tend to make people put on unnecessary weight.

Fats are also energy foods, in fact they give twice as much energy as carbohydrates. They are avoided by people who do not want to put on too much weight. Fats taste good, they make food interesting. Many of us find it difficult to eat toast without buttering it or fish without frying it. Some fats contain natural vitamins.

Proteins are nutrients that build the body and help to heal it in sickness. Various kinds of diseases are common in diets where there is very little or no protein. For non-vegetarians, the best sources of protein are meat, eggs and fowl. Vegetarians can get it from cereals such as rice, pulses such as dal, and vegetables such as beans.

Preserving food

People who are lucky enough to eat a healthy diet every day are often surprised at how often they get ill or are not able to digest the food properly.

This happens because the food is not clean enough for eating. Many times, although we do not know it, the food has begun to spoil. We are often in a hurry and are not able to choose our fruit and vegetables with care. Having bought them, we eat them.

Food is organic matter and can be attacked by bacteria. These bacteria spoil the food and sometimes there is infection in store for the eater as well.

A lot of the food we eat every day is food that has been transported from somewhere else. People have had to think of various ways of preserving food and prevent it from spoiling.

One of these ways is deep freezing which kills most bacteria. Another common way is drying because bacteria cannot normally grow on dry matter. Many foods, such as the milk we drink, are treated by heat which kills bacteria. Food is also preserved by pickling since bacteria cannot live where there is too much sugar or salt or acid.

We can add to all these methods by cleaning our food well at home. As far as possible only fresh vegetables should be bought, leafy vegetables can be cleaned in salt water or in a solution of potassium permanganate. All food should be kept covered. Ingredients such as spices and powders should be clean and be free of insect pests. When heating food, it must be heated thoroughly.

1 How are diseases carried?

2 Name three infectious diseases.

3 Why did scientists not know about bacteria until the microscope was invented?

4 What did the Italian scientist Redi discover?

5 Describe the important discovery that Pasteur made.

6 How did Pasteur prove his discovery?

7 Explain how Pasteur's method worked.

8 Describe the experiment Jenner carried out to prove his point about how the milkmaids were immune to small-pox.

9 What is a vaccine?

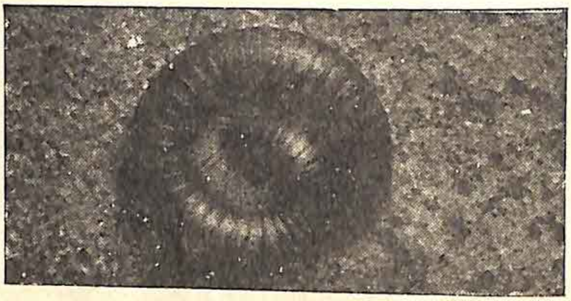
10 What was Fleming's great discovery?

11 In what two important ways is food linked to health?

12 Why does food rot and decay?

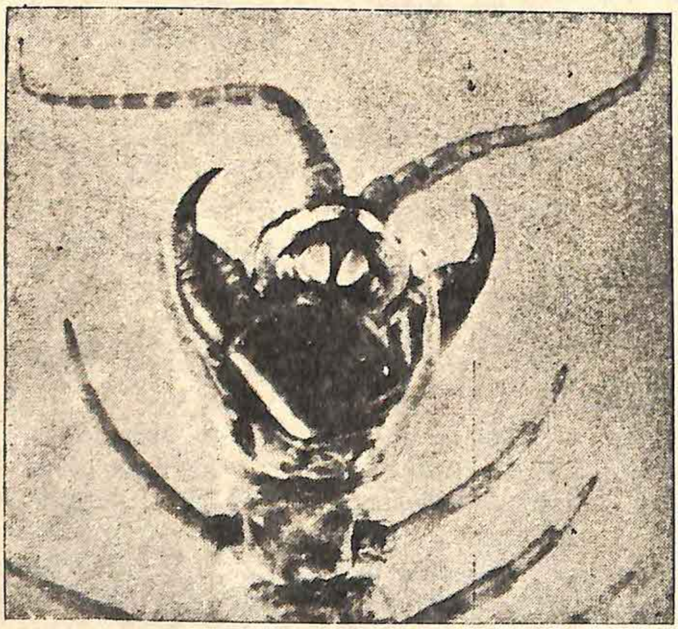
13 Describe three methods of preserving food.

10 SOME ANIMALS WITHOUT BACKBONES



A large number of animals in our world do not have backbones—about nine-tenths. Animals without backbones are called invertebrates. The largest of these groups are the *arthropods*, or animals with jointed legs. They are found everywhere from ice-bound regions to deserts.

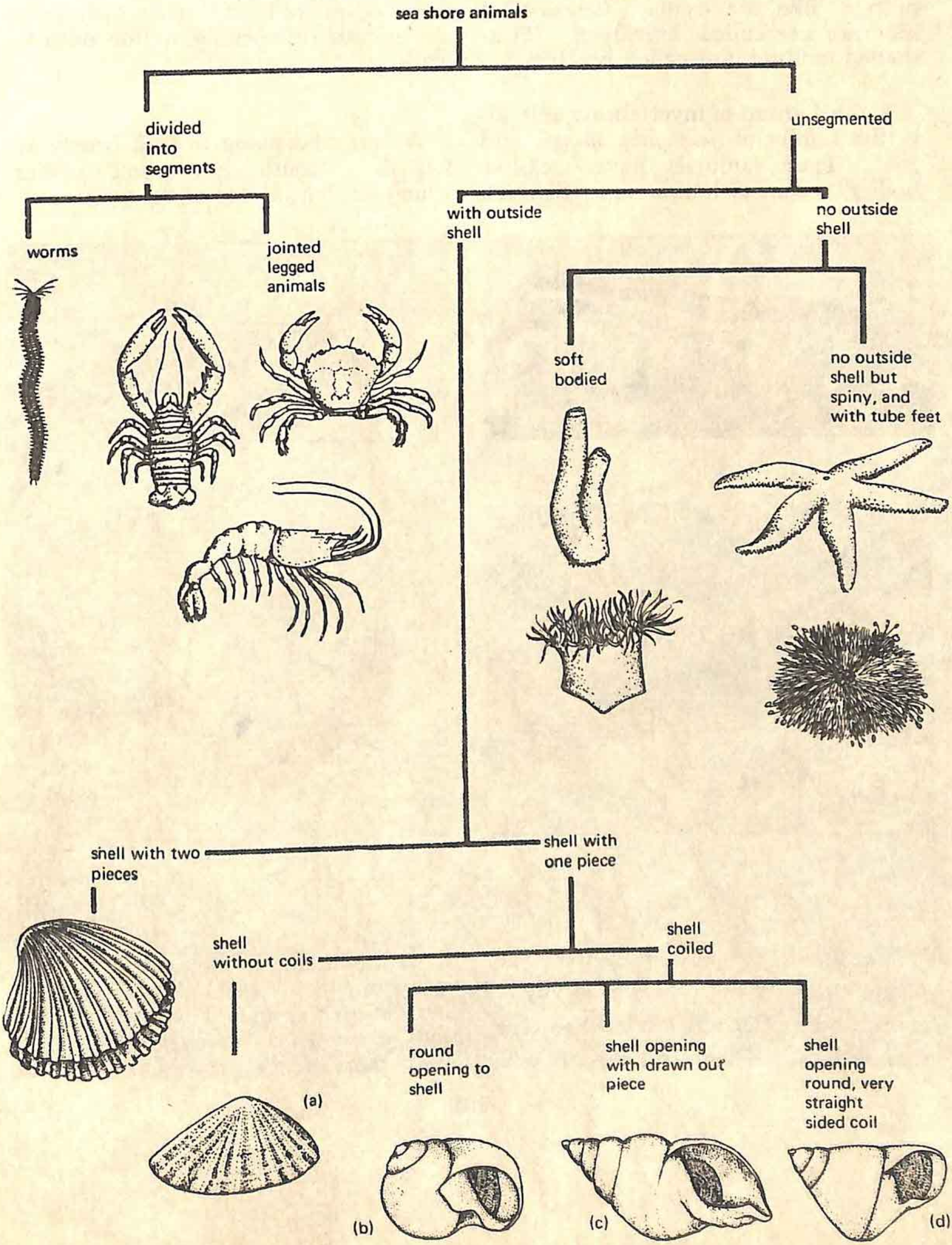
Arthropods have several features in common. They have jointed legs. Their bodies are divided into segments. They have hard outer coverings which give the animals shape, support and protection.



There are many kinds of arthropods: 1) animals with worm-like bodies such as *centipedes* and *millipedes*; 2) insects like the ant; and 3) crustaceans (or animals with shells) like crabs and lobsters. On this page you see a picture of an earthworm (top), and the head of a centipede (left).

Another group of invertebrates is called the mollusc group. Molluscs are animals that have a soft body with a hard shell to protect it. Snails and oysters are *molluscs*. Molluscs may have one shell, like the snail,

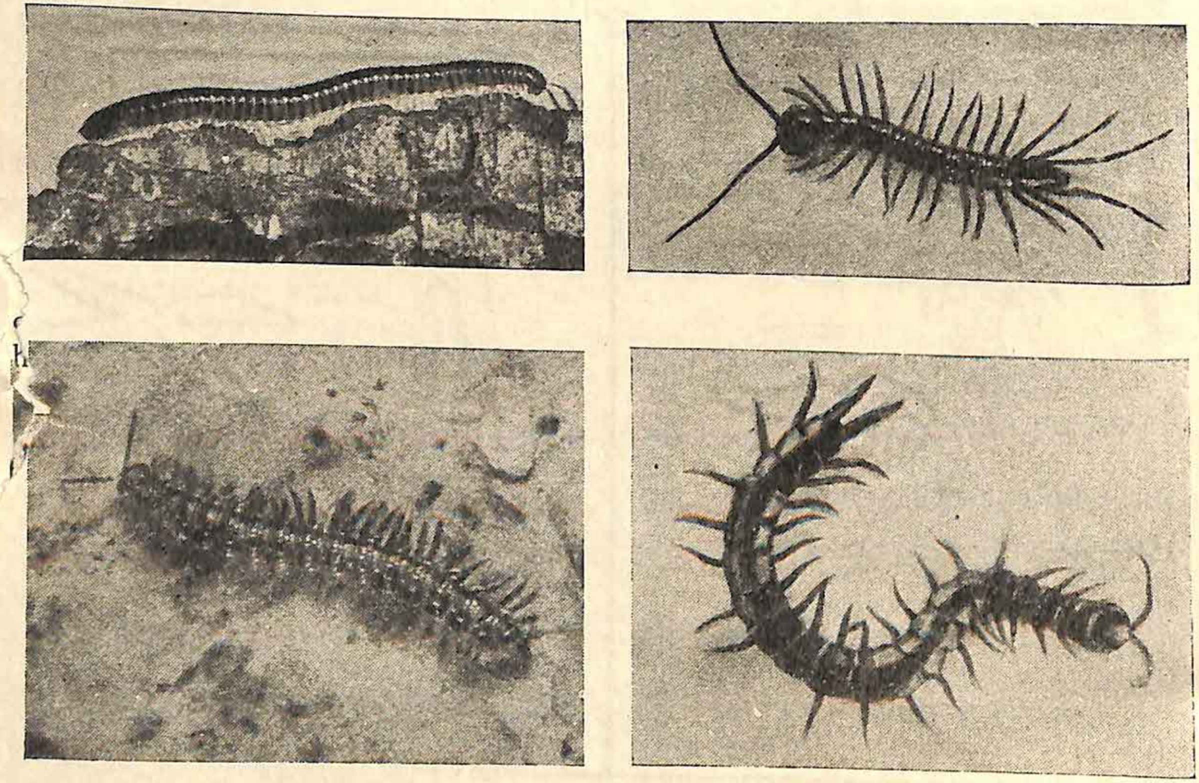
CLASSES OF SEASHORE ANIMALS



or two, like the oyster. One-shelled molluscs are called univalves. Two-shelled molluscs are called bivalves.

A third group of invertebrate animals is the family of *jelly fish*, *sponges* and *coral*. These animals have sack-like bodies, a central hollow around which their bodies are built. They have only one mouth or opening to the outside world.

We are also going to look briefly at starfish. Starfish have soft bodies which harden in case of danger.



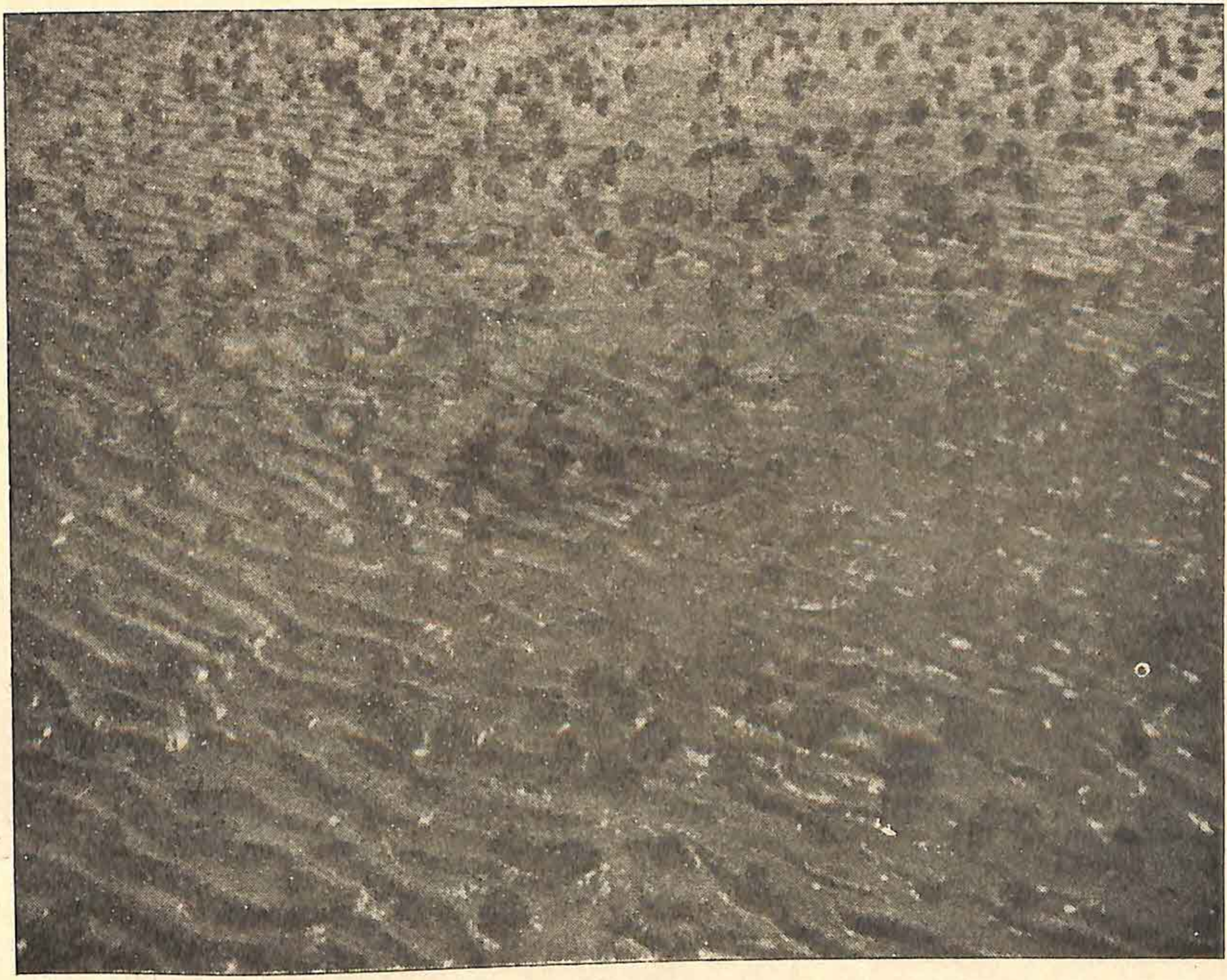
CENTIPEDES

'Centipede' means 'hundred legs'. Centipedes belong to the family of arthropods. Certain kinds have more than a hundred legs and certain other kinds less than a hundred legs. They are found in moist places on land and between rocks. They have a long body divided into many segments and many pairs of legs.

Centipedes have poisonous glands generally attached to the first pair of legs, like appendages. They live on smaller animals. You can find them in our homes. They live in the soil near the drains. On page 100 you see a centipede ready to strike an enemy.

EARTHWORMS

The earthworm is a very important animal to the farmer and to the garden. It is a long, cold and slimy creature. It wriggles when we touch it, but it is harmless.



WORM CASTS

An earthworm's body is divided into rings or segments. The adult earthworm has about 200 segments. It breathes through its skin. Earthworms make tunnels in the earth by swallowing the earth as they move along. This earth passes through their bodies, any food present in the earth is used and absorbed. The unwanted soil particles are passed out in little heaps called 'worm casts'. These worm casts contain substances which enrich the soil and are good for the growth of plants (see page 103). This is why the earth worm is called the friend of the farmer.

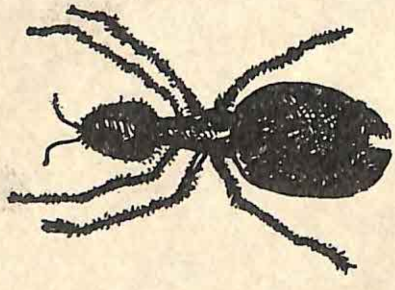
Go to the garden early in the morning and look for worm casts. If you dig at a place which is always kept wet, you may find big earthworms.

ANTS

The ant is a common insect. There are very many varieties of ants. They are of different colours. Some of them live on land and others on trees. Some of them bite, and some are harmless.

The body is divided into three definite parts. Examine an ant with a magnifying glass. Count the number of legs it has. Look at the jointed legs. Look at its antenna.

Ants live in colonies. The ant has a hard covering. The rear part is generally soft. Ants are very busy insects.



TERMITES

Termites are called white ants. They live in large colonies and destroy wood and paper. They are considered pests. They can cause a lot of damage. The body of a termite is very soft. Its mouth is adapted for chewing. In the case of bees, ants and termites, only the queen lays eggs. They all have workers in their colonies. The termite is another social animal like the ant, i.e. it lives in groups with others of its kind.

SCORPIONS

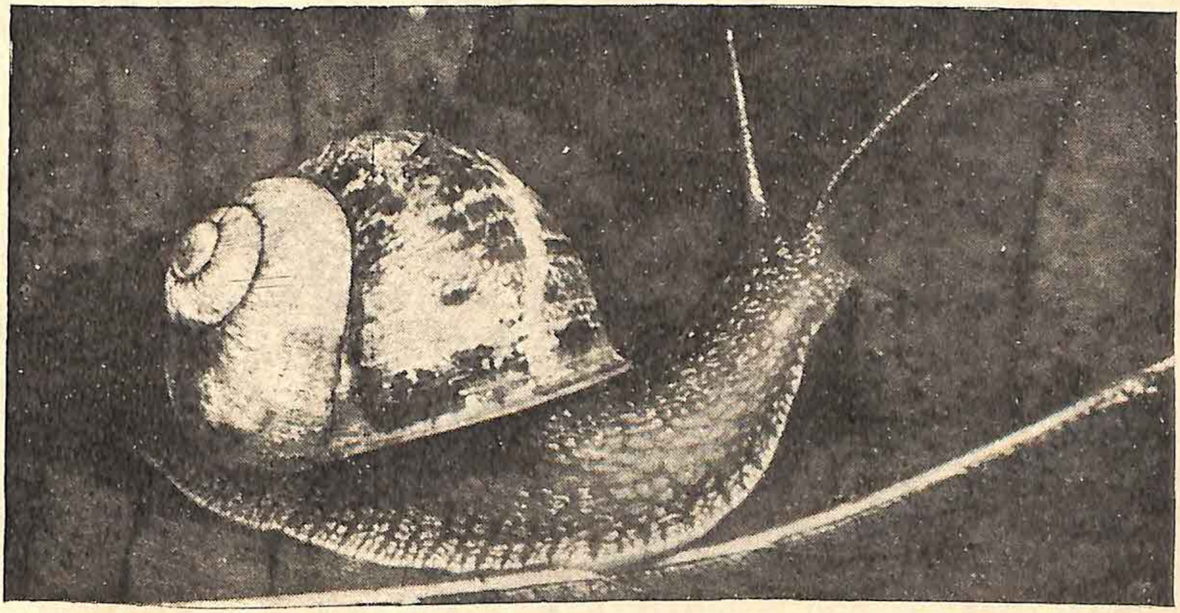
Scorpions are found in gardens, mountains and in dark places. They live in the tiles of houses and among stones.

Scorpions live on small creatures. They have poisonous stings in their tails. The body of the scorpion is segmented. It has eight legs. It has a pair of claws

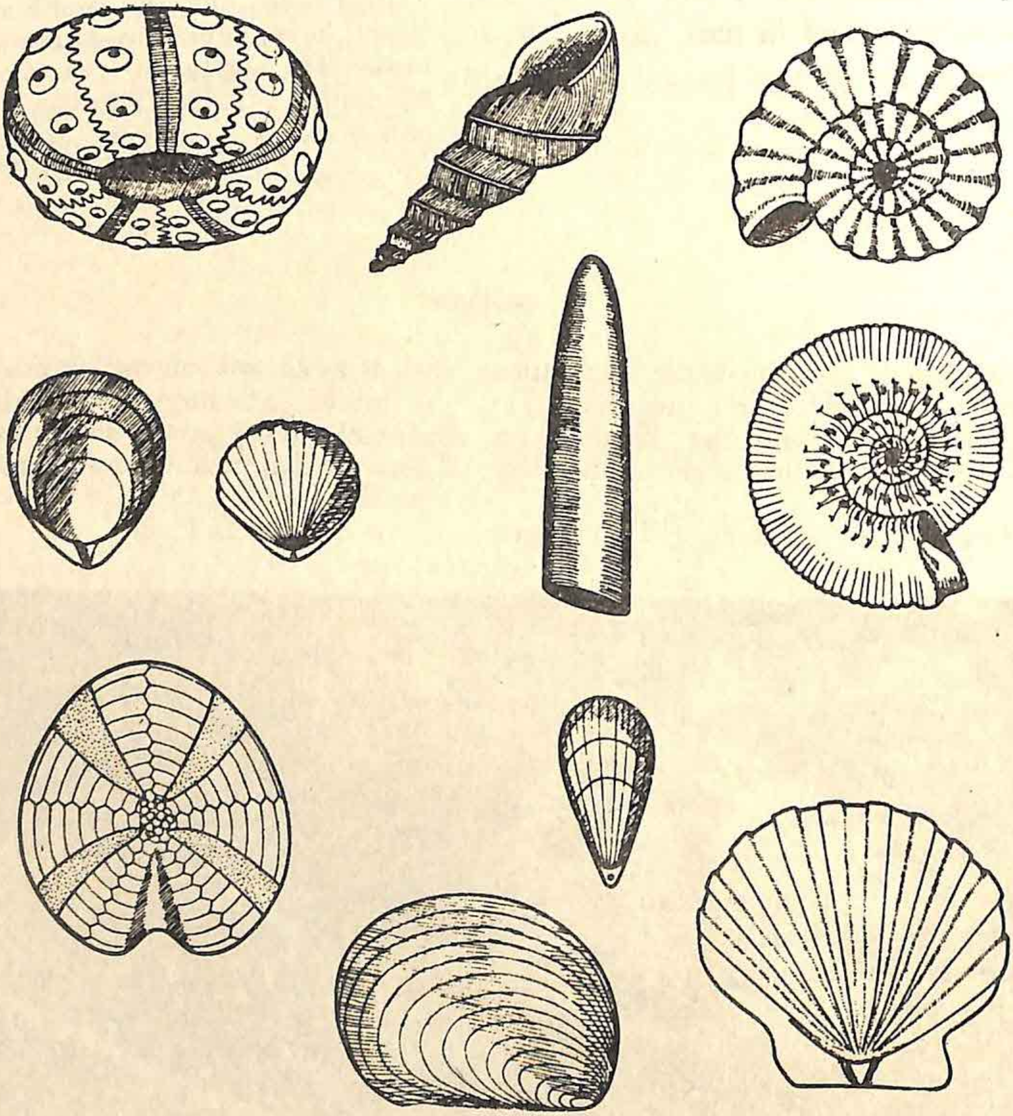
MOLLUSCS

Molluscs are soft-bodied creatures which have shells for protection The cowrie, oyster and the bivalves are examples. 'Mollusc' means 'soft body'

Cowries are molluscs. The cowrie shell is as smooth on the outside as on the inside. The animal is found inside the shell. They are of different kinds. There are little yellow cowries not more than 3 cm in length. Certain cowries are even 10 cm in length.



THE SNAIL, A MOLLUSC



SHELLS

OYSTERS

Oysters belong to the group called *bivalves*, that is, they have two shells joined together. The shell can be opened as you open a notebook. The most valuable of the bivalves are the oysters which are common in shallow and warm waters of all oceans. Oysters have irregular shells. In most species the two halves are unequal in size. The upper valve is usually smaller than the lower and full-grown oysters are usually between 1 and 25 cm in length. The great pearl oysters found in Sri Lanka and the Persian Gulf ground are as large as 30 cm. We get pearls from them (see page 110).

If you have the chance to walk on a sea-shore you can get a number of shells of bivalves. You may find scallops, razor oysters and other oysters.

Snails are common garden animals. They have soft jelly-like bodies which are not divided into segments. They move on a part of the body called a foot. This foot exudes a sticky substance which help the snail move smoothly over dry and rough surfaces.

A snail's body is protected by a hard shell of lime. When danger threatens, a snail can withdraw into its shell.

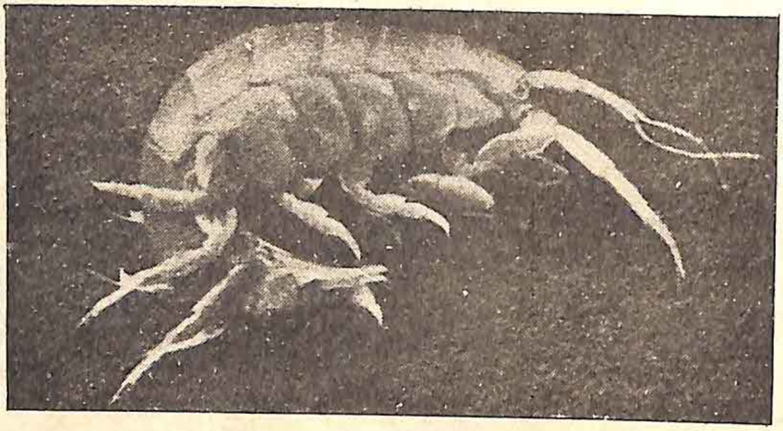
CRUSTACEANS

Crustaceans are animals whose bodies are protected by shells. This shell is a good defence and protects these animals from harm. We looked at shells as an adaptation for protection in Chapter 5.

The shells of crustaceans are jointed so that they can move. Most crustaceans live in the sea. The family includes crabs, lobsters, prawns and shrimps. They vary greatly in size and shape. Many of them (such as crabs) pass through a process of change in shape and form as they grow up.

Animals like the crab have certain well-marked features. One of these is that their bodies and limbs are divided into segments. The second common feature is that their bodies and limbs are covered with tough, lime-covered shells. This shell is flexible and allows the animal to move in various directions. The third common feature is that crustacean babies hatch from eggs. The babies look very unlike the parents.

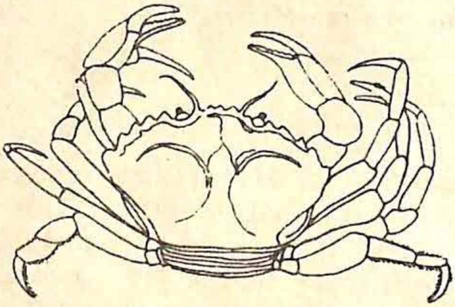
Crustaceans feed on a variety of things. Some of them are scavengers and live on seaweed floating near the banks. They help to clean up masses of this floating seaweed. Some crustaceans are parasites. They attach themselves to other sea-animals and feed on them. Some larger fish, in turn, feed on these animals with shells.



A LOBSTER

The crab family makes up a large part of the group of crustaceans. Most crabs live in the sea. Many live in lakes and some even on dry land.

You can recognise a crab easily by its carapace or the shell on top. The abdomen below it is a triangular flap. Crabs have well-developed pincer claws and four pairs of legs for walking, digging and sometimes for swimming. The hermit crab does not have its shell. It protects itself by finding the empty shells of other animals and living in them!



JELLY FISH

Jelly fish are soft and slimy animals, living in water. They have no bones in them. They are completely soft. Some are small and some are large. Some are harmless and some have poison in them. Most of them float in water. Some of them stick to rocks in water.

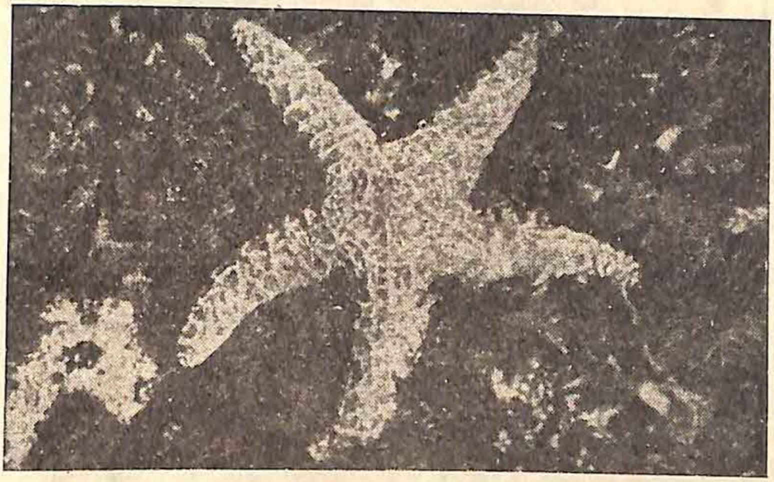
If you live near the sea or the backwaters you can see the jelly fish thrown on the shore by fishermen. The jelly fish stings fishes with poison and eats them. Jelly fish move by the action of wind in their air-filled floats.

STARFISH

Starfish live in rocky places near the sea or in the sandy bottom of the sea. They stick to rocks. Under each arm is a ridge containing many tubes. These tubes end in small suckers. They help the starfish grasp the surfaces of things. The suckers are strong enough to help the starfish catch hold of a bivalve and pull its shells apart.

Starfish have five, six or even ten corners or arms in their bodies. Certain thin varieties are called serpent starfish. A starfish's body is flexible and soft. Only the covering is hard. You can get a hard star only when the starfish is dried.

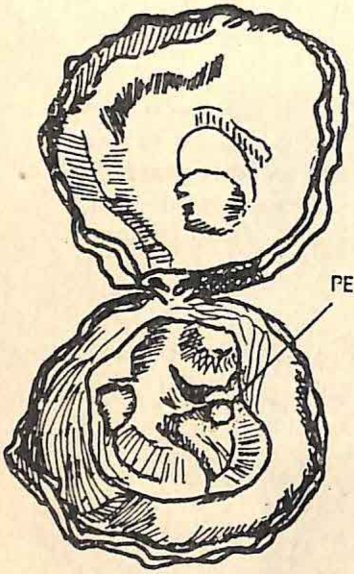
Starfish are found in different colours but brown is the common colour.



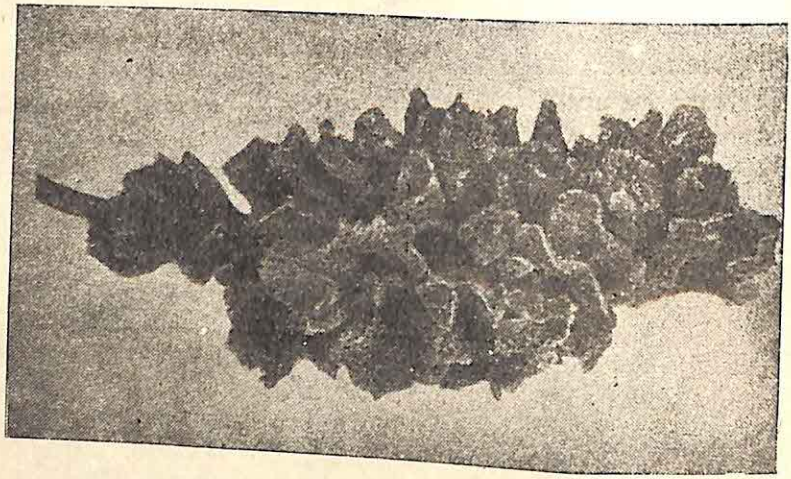
SPONGES AND CORAL

Sponges: Sponges look like plants but they are very simple animals which live together in groups or colonies. Each animal is microscopic in size. All these animals living together in one colony help to build up a single skeleton which is stiff. It becomes hard when dry and soft when wet. This skeleton is the sponge which we use for washing things or scrubbing ourselves. The sponges are fixed to the sea bed. The walls of the sponge have many small holes or pores. Water can enter it through these holes. At the top of the sponge is an opening. This is the mouth.

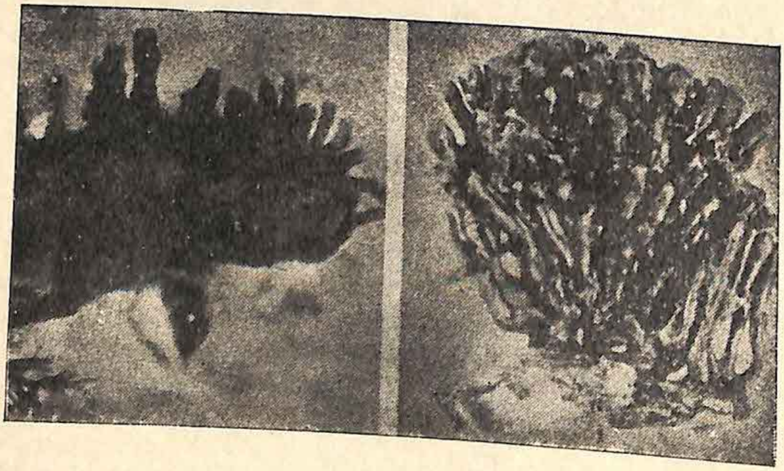
There are many types of sponges.



AN OYSTER (A BIVALVE)



A SPONGE



CORAL

Some have branches and others look like vases. There are horn sponges, glass sponges and tufted sponges.

Corals: The corals we know are really the hard skeletons of microscopic animals which live in groups. These animals are called polyps. Each polyp has a stem-like body and a number of arms at the top. These arms are also known as tenacles. All these are microscopic. The corals catch still smaller organisms for food.

All corals are fixed to the sea bed or rock. Some of them have branches like plants. They may be white, red, purple, yellow or green in colour. They sometimes choke the sea. The mushroom corals, stag-horn corals and brain corals are some of the common varieties. Precious coral is red in colour. It is cut and used for making ornaments.

1 Mark the odd one out by underscoring the word.

a) jelly fish, starfish, centipede, pomfret, shark

b) cow, sheep, horse, cat, goat, deer

c) centipede, scorpion, bee, oyster, starfish

d) stork, parrot, heron, woodpecker, duck

e) ant, bee, earthworm, fly, butterfly

f) earthworm, scorpion, cobra, centipede, jelly fish

g) cowrie, oyster, starfish, jelly fish frog

h) sponge, bean plant, coral, ant, starfish

i) bees, ants, termites, starfish

2 What are the four classes of invertebrates you have just learnt about? How are they different from one another?

3 Write short notes on:

a) Arthropods

b) Molluscs

4 What are the main differences between a crab and an earthworm.

5 How do snails travel? What special features do they have for protection?

6 Look at the pictures of the snail on page 105 and the crab on page 108. Draw them in your books. Label the parts.

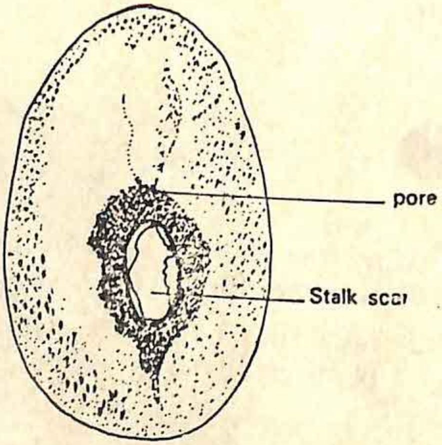
11 HOW SEEDS GERMINATE

Take a handful of seeds of different kinds. You can easily find the seeds of paddy, wheat, peas, beans, ragi, mustard and groundnuts. Some of them are so tiny, you will need to look at them through a powerful magnifying lens. You will be able to see them better if you soak them in water for a while.

Seeds look very different when you look at them from the outside. There is a great variety in size, shape, colour and texture. We have also learnt about how seeds are scattered and how they therefore have different features to enable them to be carried away from the mother plant. Seeds, therefore, look different from the outside. But the structures inside these seeds is very similar.

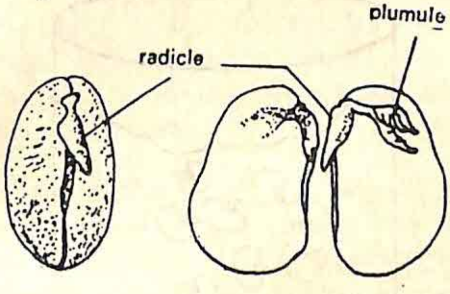
When studying seeds, it is easier to look at bigger seeds because you can handle them. Take the seeds of a bean or a groundnut. You will find that these seeds have a coat or a covering. This coat is thin and transparent in some seeds and thick in others. Now turn the seed over till you see a spot or scar, the helium This shows you the point at which it was attached to the plant or fruit. You will see the helium best in peas and in bean seeds.

Now soak the seeds in water for a few hours. Take them out and wipe them dry gently with cotton wool. Now hold the seed firmly between your finger and thumb and squeeze it gently. You will see water or a water bubble pressing out of a tiny hole near the stem scar. This is the pore of the seed. It is through this hole that the seed takes in water. There is no other opening through which it can do so.



If seeds have water; they must *need* water. We will find out later in this chapter how a seed needs water in order to germinate.

Take the bean seed, peel off the seedcoat and open it at the split. It will come apart neatly in two halves. These halves are called the seed leaves or *cotyledons*. Seeds of flowering plants have either one cotyledon or two. Bean, pea seeds and groundnuts have two cotyledons. Rice, maize and corn have only one cotyledon.



Cotyledons protect the young shoot and root. They are usually the largest and fleshiest parts of the seed. This is because they contain food substances such as starch.

Now split the bean seeds open and examine them under a magnifying lens. You can see the young root or *radicle* at the tip of the cotyledon (see illustration). You can also see the young shoot which will become the leafy part of the plant. This is called the *plumule*.

HOW A SEED GERMINATES

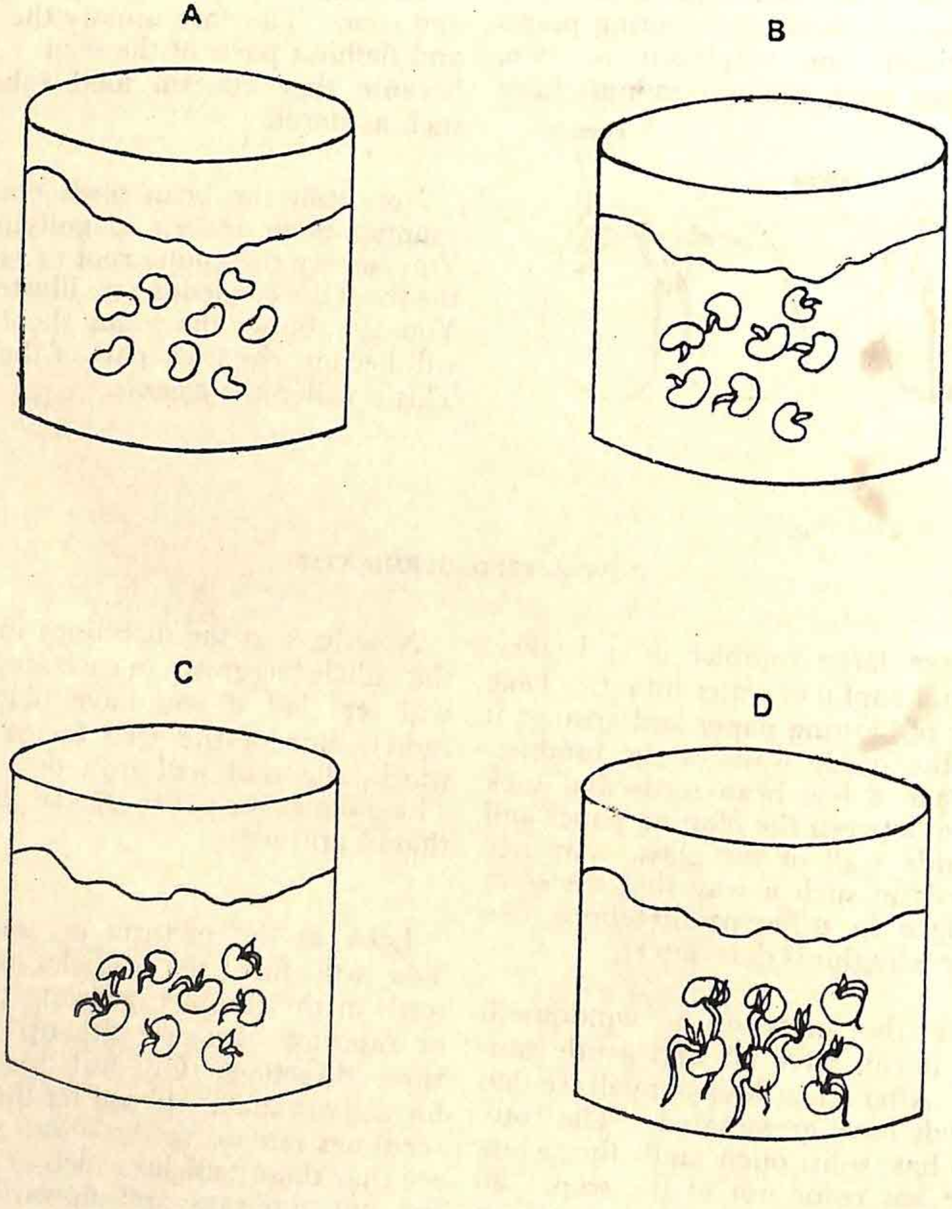
Take a large tumbler or a beaker. Pour in a cupful of water into it. Take a piece of blotting paper and arrange it along the inside walls of the tumbler. Now take a few bean seeds and tuck them in between the blotting paper and the inside wall of the glass. Arrange the seeds in such a way that the stem scars face in different directions (we will see why this is done later).

Place the glass on a window-sill where it can have air and gentle sunlight. After a few days you will see that the seeds have germinated. The cotyledon has split open and the white radicle has come out of the seed. So has the plumule. Sometimes you can clearly make out the tiny green leaves.

Now look at the directions in which the radicle has grown in each seed. You will see that if you have placed the radicle side of the seed facing downwards, the root will grow downwards. The shoot grows in the *opposite* direction, that is, upwards.

Look at the pictures on page 114. You will find the radicles of some seeds in the tumbler growing upwards or sideways, because the tip faces in these directions (C). But this is only for a short spell. If you let the young seedlings remain in the glass, you will see that those radicles which are thrusting out sideways and upwards, have turned in a downward direction (D).

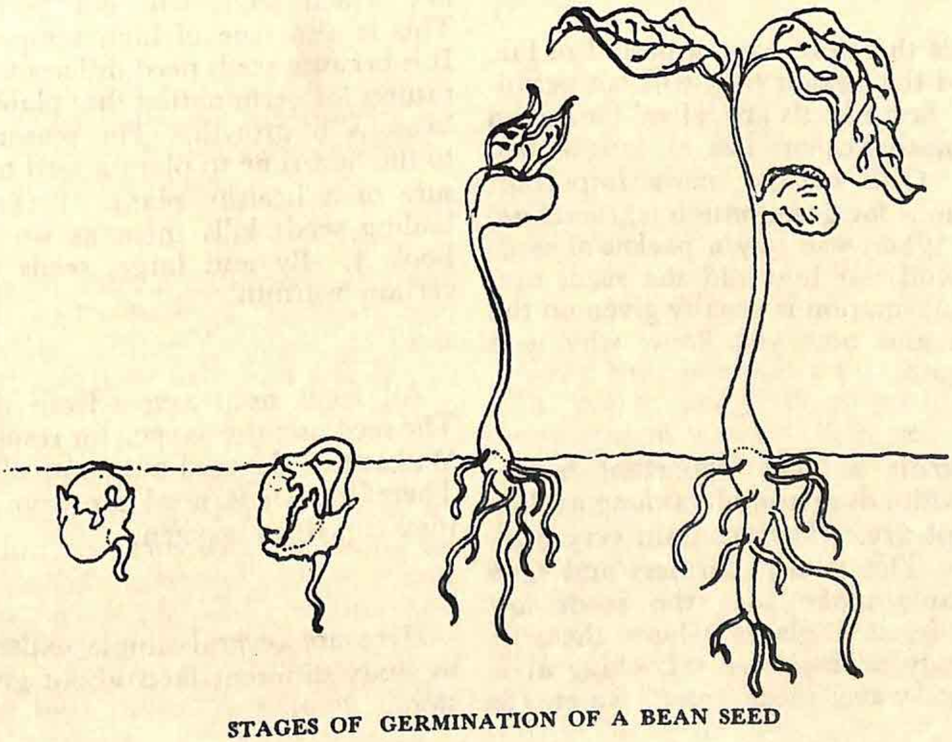
GERMINATION



You have just looked at a strange and wonderful fact about plants. The main root *naturally* grows in a downward direction. We will understand why this is necessary if we remember that roots anchor the plant to the soil. To do this they must penetrate the soil, spread out and grip it. Roots also draw in water and nutrients from the soil. Gravity is one of the forces that pulls the root tip downwards.

For a different set of reasons that we have already learnt about, the shoot grows upwards. The main stem and leaves of a plant are always above the soil. The leaves need air and sunlight to make food.

Here is a diagram of the different stages in the germination of a cow-pea seed. The cow-pea seed has two cotyledons. In the first part of the diagram, the radicle has broken through the walls of the cotyledon and come out. In picture 2 the stem and plumule have emerged from the plant. The radicle in picture 3 has branched into a root system. The cotyledon has grown on the stem. The leaves have grown bigger. In picture 4 you see how the leaves have branched out. You can even see a tiny shoot in between. The



STAGES OF GERMINATION OF A BEAN SEED

cotyledons are slowly drying up. When the plant uses up all the food in these, the cotyledons will shrivel, dry up and fall off. The plant is now on its own.

CONDITIONS FOR GERMINATION

As we saw in Book 4, not all seeds germinate, and many seedlings die in the process of germinating. Seeds preserved for too long will not germinate. When the ruins in Egypt were excavated, the men found seeds more than 2000 years old in boxes! The seeds looked perfectly good from the outside, but actually they were dead seeds. Nothing would make them germinate.

Seeds therefore have a period of life. Beyond this period they will not germinate. Some seeds are 'alive' for only a few months, others last as long as two years. One of the most important conditions for germination is, therefore, *time*. When you buy a packet of seeds next, find out how old the seeds are. This information is usually given on the packet and now you know why it is important.

Water is another important factor. Seeds will not germinate as long as they are kept dry. They contain very little water. This is why farmers and seed merchants make sure the seeds are stored in dry places where there is absolutely no moisture. Looking at it another way, seeds *need* water to germinate. If you plant a few in soil that is completely dry and do not water the seeds, germination will not take place.

Temperature is another important condition. Seeds differ in their ability to withstand high and low temperatures. There is a certain low temperature below which seeds will not germinate. This is also true of high temperature. It is because seeds need different temperatures for germination that plants have 'seasons' of growth. This season refers to the best time to plant a seed to make sure of a healthy plant. Freezing or boiling seeds kills them as we saw in Book 4. By and large, seeds need a certain warmth.

All seeds need *oxygen* from the air. The seed uses the oxygen for respiration. Without it, the seed automatically dies. Therefore, seeds need air from which they can draw oxygen.

Here are several simple experiments to study different facts about germination.

To prove that seeds need moisture, light, warmth and air

Take five small beakers or cigarette tins. Fill them three-fourths full with dry garden soil. If the soil is dampish, dry it by exposing it to the sun. Take five bean seeds and plant them in each beaker 2 cm deep. Cover them up with a layer of dry soil. Label the beakers A, B, C, D and E. Now here is what you do (See page 118).

Beaker A: Place the beaker in a position where it has light and air. Make sure it has no water and that it does not have any source of moisture.

Beaker B: Pour a tablespoon of water on it. Make holes in a large tin (to let in air). Invert it over the beaker and keep it in a dark place.

Beaker C: Pour a tablespoon of water over the seed. Pack ice cubes all over the beaker. Place it in a position where it has both light and air.

Beaker D: Water the seed. Invert a bell-jar over the beaker. Place a lit candle inside. The candle will burn up all the oxygen inside the bell-jar. You will know it has all been used up when the candle goes out. To prevent any air escaping into the bell-jar, seal it just *after* the candle has gone out, with melted wax.

Beaker E: Water the seed. Place the beaker in a warm place where it has plenty of air and light.

Leave all the beakers in their respective positions for three days. Then bring them together. Write notes on what has happened and why. If you have done the experiment properly you will find that the seed in Beaker E has germinated healthily. The seeds in the other beakers either will not have germinated, or they will have a sickly appearance.

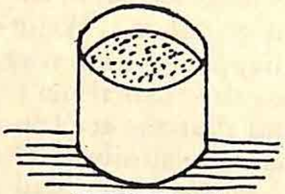
To prove that a seed draws in water through its pore

Take four bean seeds again. Take a cylindrical piece of cork and make notches in it. Tuck a seed into each notch, place two seeds with the pore-end facing downwards and two with the pore-end facing upwards. Float the cork in water for a few hours.

You will notice that the seeds placed with pores facing downwards (and submerged in water) will have swelled with the intake of water. There will be no change at all in the seeds which had the pores facing upwards and above the level of the water. Remove the seeds. You can weigh them one against the other if an accurate weighing balance for small things is available. Cut one of each of the seeds. The swollen seed will be full of water.

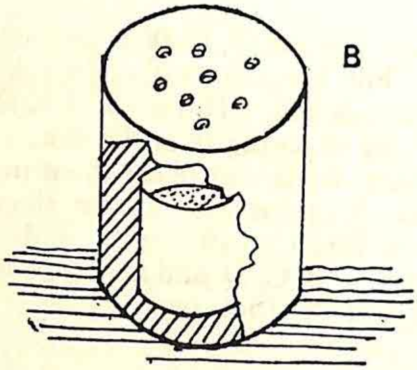
SEEDS NEED WATER, LIGHT, WARMTH AND AIR TO GROW INTO PLANTS.

A



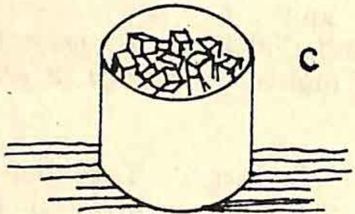
No Water

B



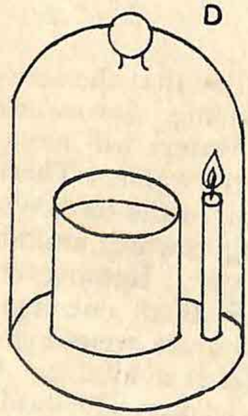
No Light

C



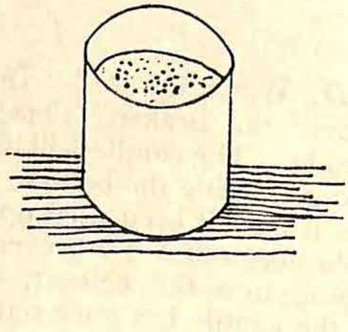
No Warmth

D



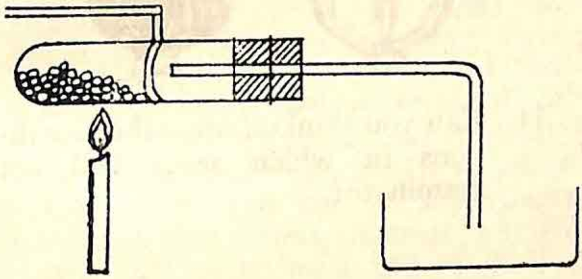
No Air

E



To prove that seeds contain water

Take a few fresh green seeds from the pods. Put them into a test-tube as shown in the picture. Light a candle and place it under the test-tube as shown in the illustration. Fit a cork in the test-tube and insert a bent glass tube through a hole in the cork. The other end of the tube bends over a saucer.

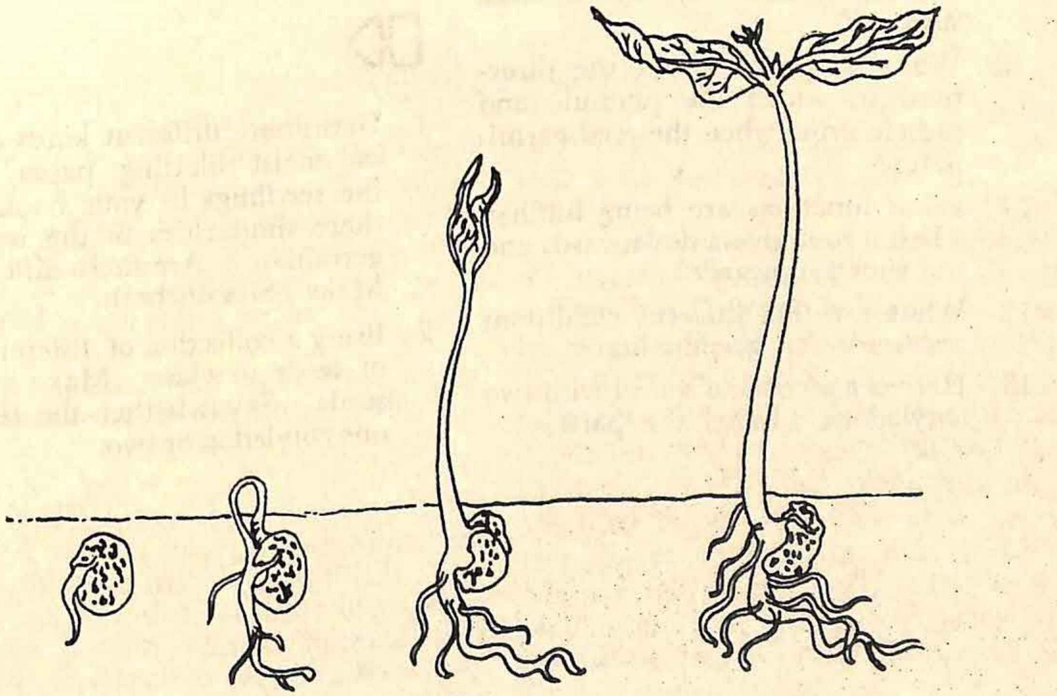


After a while you will see drops of moisture along the walls of the bent tube and on the surface of the water. Where does this come from? How do we know it was water in the seeds?

1 How do seeds differ in their outward features?

2 What inside features make all seeds more or less alike?

3 What are cotyledons and what purpose do they serve? What happens to them as a seedling grows?



4 Why are cotyledons usually fleshy?

5 Name 3 seeds which have one cotyledon, and 3 which have two.

6 What purpose do the following serve:

a) the seed skin

b) the pore

7 Look at the illustration of the germination of a castor-seed on page 119.

Describe the different stages of germination in detail.

8 Why is temperature such an important condition for germination?

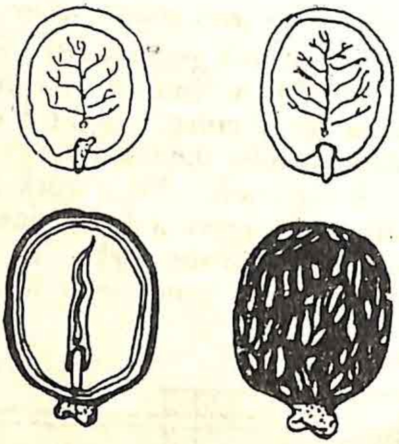
9 Why, in a seed-grains market, do the buyers have to be careful about the seeds they buy for crops? What points do they have to make sure of?

10 What is special about the directions in which the plumule and radicle grow when the seed germinates?

11 What functions are being fulfilled when a root grows downwards and the shoots upwards?

12 What are the different conditions necessary for germination?

13 Here is a section of a seed with two cotyledons. Label the parts.



14 Can you think of any other conditions in which seeds will not germinate?

1 Germinate different kinds of seeds on moist blotting paper. Draw the seedlings in your books. Are there similarities in the way they germinate? Are there differences? Make notes on both.

2 Bring a collection of different kinds of seeds to class. Make a list of seeds. Say whether the seed has one cotyledon or two.

12 DISEASES AND ILLNESSES

Accidents and illnesses are occurring around us all the time. They have become a part of life and living. Usually, both accidents and illnesses are small events that we can deal with. Today there are many more hospitals than there used to be, say, two hundred years ago. We saw in the chapter *Man against Disease* how it was discovered that bacteria and smaller organisms cause disease. This discovery has made it somewhat easier for us to fight disease. The main idea was to avoid or destroy the conditions which allow the organisms to develop and attack us.

We will look at some points of general hygiene and health before we look at some common ailments and diseases.

HYGIENE AND HEALTH

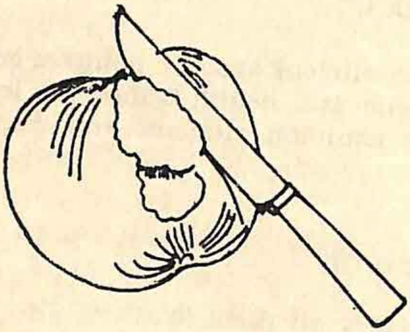
For many of us cleanliness and taking care of ourselves is a matter of commonsense. Unfortunately, a large number of people do not have this knowledge. Because of this, disease everywhere remains a constant threat.

Most diseases are caused by organisms that travel in air, water or the food we eat.

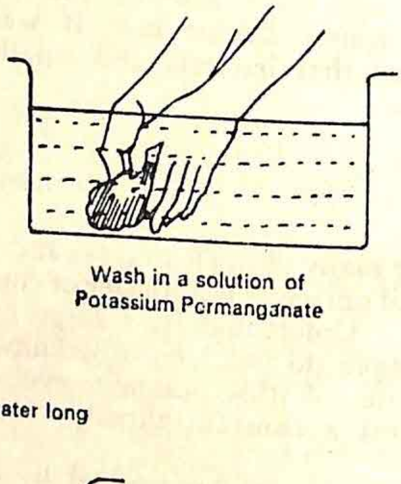
It is difficult to control disease germs carried by the air. In infectious diseases this is particularly difficult. Air pollution and dirty surroundings make the risk greater. This is because most organisms thrive in organic, decaying, damp matter. A lack of sanitation promotes all these features, also water that is left to stagnate.

Water-borne diseases are comparatively easier to control. Water-supply systems usually provide water that has been filtered and chlorinated. But this, unfortunately, is not enough to make the water completely safe to drink. Many disease germs can withstand and survive through the chemicals that are used to purify water. It is necessary for us to boil water to make it safe to drink. Then again, boiled water must be poured into clean containers. It must be used as quickly as possible in the space of a day.

Food is one of the biggest sources of disease. Many of us are not as careful as we should be in making sure that food is completely germ-free. People often eat in crowded market-places where the food is exposed to flies. It is in conditions like this that the dreadful disease called cholera occurs. Flies sit on the exposed food. Their maggots are left behind and are the breeding ground for cholera germs. These germs pass straight on to the eater. It is only a matter of time before the bacteria get a hold on his body.

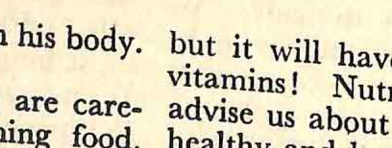


Cut away spoilt parts



Wash in a solution of Potassium Permanganate

Do not leave to soak in water long



Another way in which we are careless is in buying and cleaning food. Sometimes we buy vegetables that are not fresh. Many fruits and vegetables are eaten raw. If they are damaged or over-ripe these foods can breed germs. A safer way to eat green vegetables is to wash them in a solution of potassium permanganate. The spoilt or withered parts must be cut away clean. The vegetables should never be left to soak in water very long.

There are different ways of cooking which ensure that the germs are destroyed. Unfortunately, when you overcook or over-boil, it may be safe to eat but it will have lost its nutrients and vitamins! Nutritionists (people who advise us about what kinds of food are healthy and how to get the best things from food) are now able to guide us on how to cook food in such a way that we preserve most of the nutrients.

In some of our bigger cities, food is preserved in large quantities by deep-freezing. Many of us do not know that the food is germ-free as long as it is in the deep-freeze. The moment it is taken out, and as it melts, germs can begin to lodge in it. This is particularly true of meat. The food should therefore be cooked as soon as possible after it has melted.

One of the dangers of cooking frozen food is that the outside portions melt first. We think that the ice has melted completely. Remember that the frozen water right inside takes long to melt because it is not open to the air and heat. Now here is an interesting case of a family that got ill.

The wife brought home a frozen chicken. She poured hot water to melt the ice frozen over the chicken. It now looked ready to cook. She smeared oil and spices over it and put it into the oven to bake for an hour. The chicken came out of the oven looking nicely baked. The family ate the chicken with great relish though they complained that it was not hot enough. The next day they all had severe pains in the stomach followed by diarrhoea. This became so bad that they had to be admitted to hospital.

It is interesting how this happened. The frozen water in the chicken had not melted completely. Only the ice *outside* had melted. There was still a block of frozen water right inside the bird. The baking was not long enough to allow this ice to melt and to heat the water to boiling point. The bacteria that developed and grew in this warm water were therefore not killed in the baking heat.

Some elementary rules to observe about food are that

1 it should be cleaned thoroughly.

2 you should wash your hands when cooking.

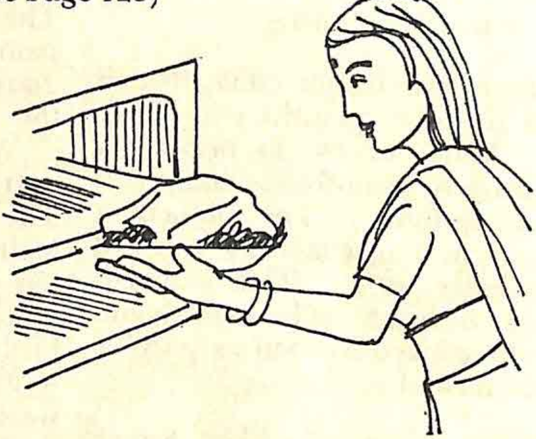
3 you must not ever cough or sneeze over food. In fact, try not to cook if you have a cold or cough.

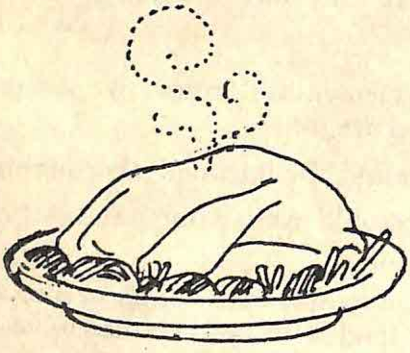
4 large frozen foods must be allowed to melt completely before they are cooked.

INFECTIOUS DISEASES

Infectious diseases are those which spread easily from a person who has it to a person who does not. We have just seen how disease germs are carried by air, food, water and by unhealthy habits. For example, the habit of

(See Page 123)





touching everything you see and of putting unclean hands into your mouth can help germs enter.

Some diseases are more easily caught than others. Measles, chicken-pox, mumps and small-pox are highly infectious. The disease organisms are carried through the air. It is therefore very difficult to control getting the disease if you are near a person who has it.

Small-pox is probably the worst of all these. People of all ages can catch it. It is a disease in which blisters develop all over the body. When they dry and drop off they leave scars behind. Small-pox is now no longer a disease to be feared in the world. The World Health Organisation organised teams of doctors in every country to fight it. The disease has at last been almost wiped out. However, everyone needs to be careful. Babies and young children are vaccinated against small-pox. We learnt about vaccination in the chapter *Man Against Disease*.

Measles and chicken-pox are also diseases in which the body gets rashes. Each disease has a different set of signs. We usually have high fever before measles. Some children can get severe chest colds after measles, and this is very dangerous. In chicken-pox there is usually no fever. Children play as if there is nothing wrong with them!

Some infectious diseases are dangerous to life. Two of these are diphtheria and tuberculosis (or TB). Diphtheria has certain signs and doctors can see these immediately. Children find it difficult to swallow. There is often fever and bleeding from the nose. Parts of the body can get paralysed. Tuberculosis is carried in the air. The air contains the dry spit of people who have it. The disease usually has a harmful effect on the lungs. Doctors have found different ways to treat it and to cure the patient.

Cholera, malaria and typhoid fever are carried through water. In India, there are hundreds of deaths every year from cholera. In this disease the germs attack the intestines. They are spread through infected food, flies, water and by living in dirty surroundings.

Malaria is caused by mosquito bites. The signs of malaria are high fever and shivering, especially at night.

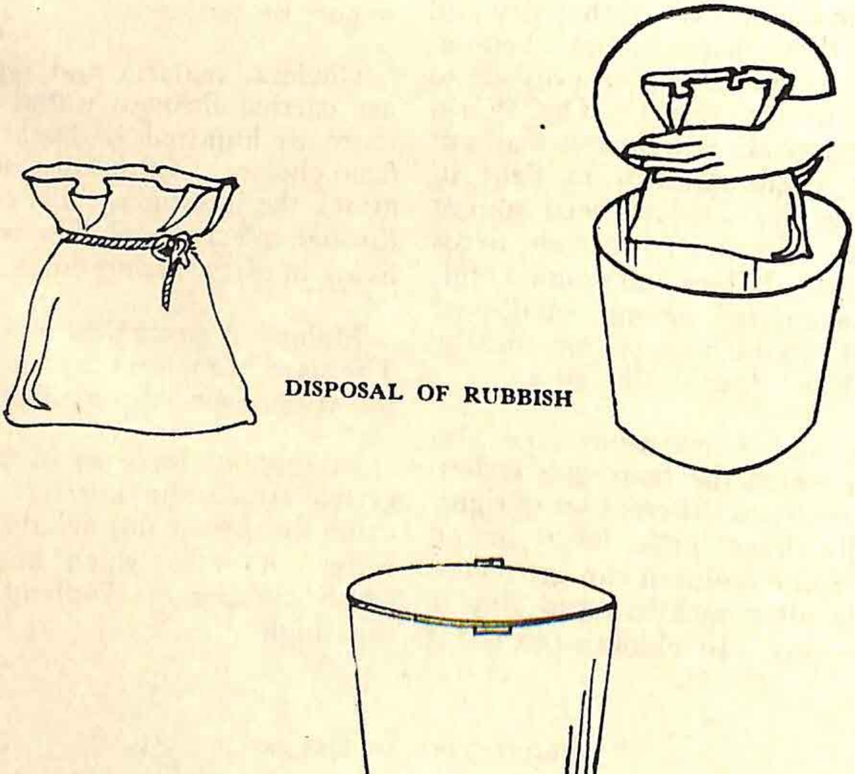
In typhoid fever as in cholera, the germs attack the intestine. You can catch the disease through dirty food and water, or milk which has not been heated properly. Typhoid fevers run very high.

PROTECTING OURSELVES

We can never be completely free from disease and illness. But we can *help* to prevent them by observing certain 'musts' in our lives.

Hygiene: The first of these 'musts' is hygiene or keeping clean. We must keep clean and keep our surroundings clean. Water must never be allowed to stand around our houses. Inside, our houses must be swept, cleaned and dusted everyday. Food must never be left open or allowed to stay for long. If the food smells bad, *never* take a chance and eat it. We have already looked at healthy ways of cleaning and cooking food.

Household pests: Insects are great carriers of disease, especially flies, cockroaches and mosquitoes. Many insecticides (medicine to kill insects) are available today. They must be used carefully and regularly. One of the ways of preventing flies is using a fine wire netting on doors and windows. Flies are too big to enter through it. They usually gather where there are rubbish heaps, or where food particles are left lying around. The best way is to wrap rubbish waste in bags and put them in dustbins with lids, as shown in the illustration. The bin must be cleared and cleaned regularly.



DISPOSAL OF RUBBISH

Mosquitoes can also be prevented in this way. They are found in large numbers wherever there is standing water. They are also found where there are many plants and weeds. Mosquitoes carry malaria. There are many ways of reducing their number. Many people use creams to prevent them from biting, or sleep under a mosquito net.

Vaccinations: Some diseases can be prevented by our making ourselves immune to them. We can get ourselves vaccinated against small-pox or polio. Polio is a disease in which our limbs get so weak that they cannot work for us. We can protect ourselves against typhoid by taking injections. There are vaccines to prevent tuberculosis, whooping cough and diphtheria.

On page 128 is a set of pictures to show you how the polio vaccine works.

COMMON ILLNESSES

Everyone gets coughs and colds. Some people get them more than others. A cold is one of the commonest ailments.

Ailments like this help us remember how important it is to have clean habits. Here are some simple rules. You probably know them.

1 If you cough, cover your mouth, so that the germs are not spread on others. When you sneeze, cover both your nose and mouth.

2 Use a clean handkerchief. At the end of a day, after you have used it, wash it in a disinfectant solution.

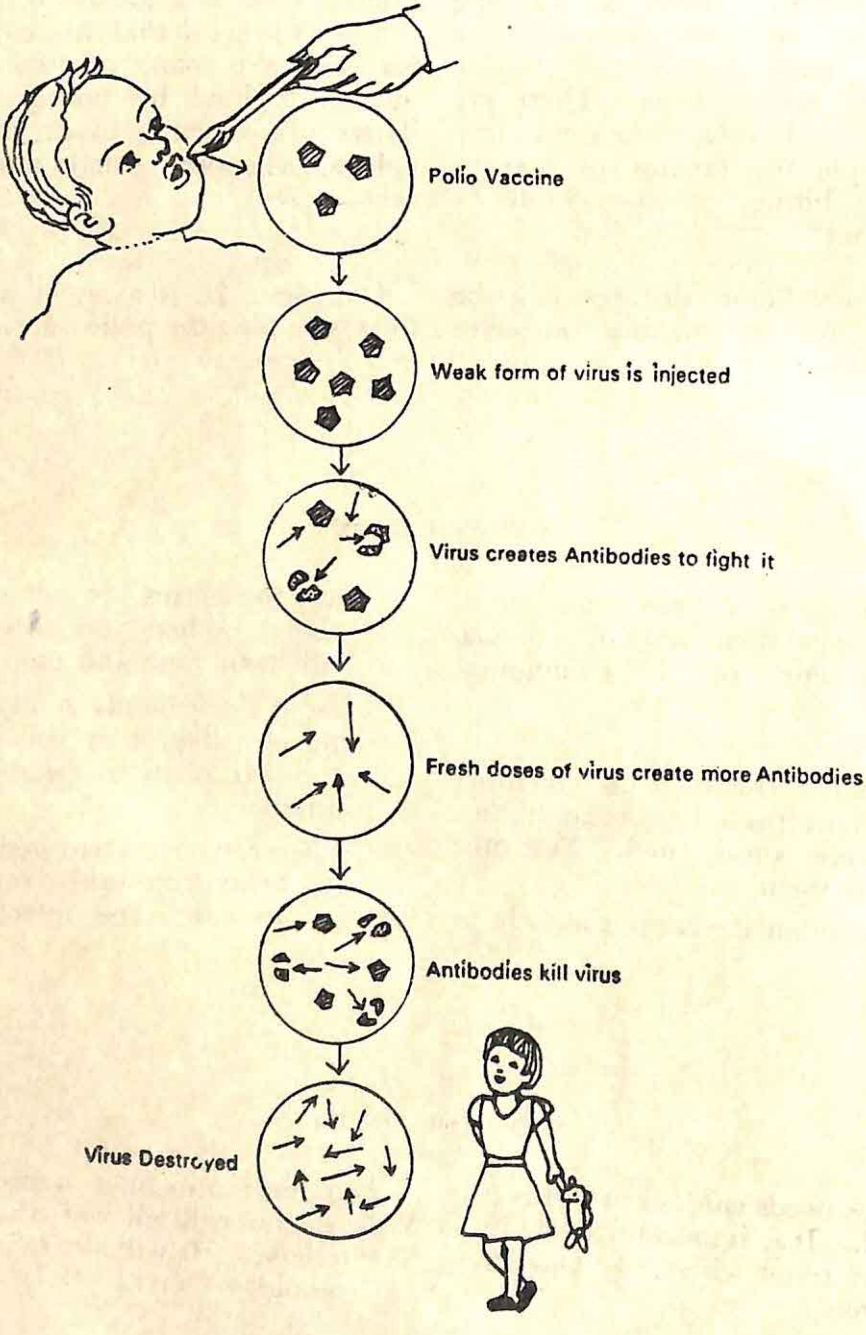
3 When you have a bad cold or cough, stay away from others so that they do not catch the infection.

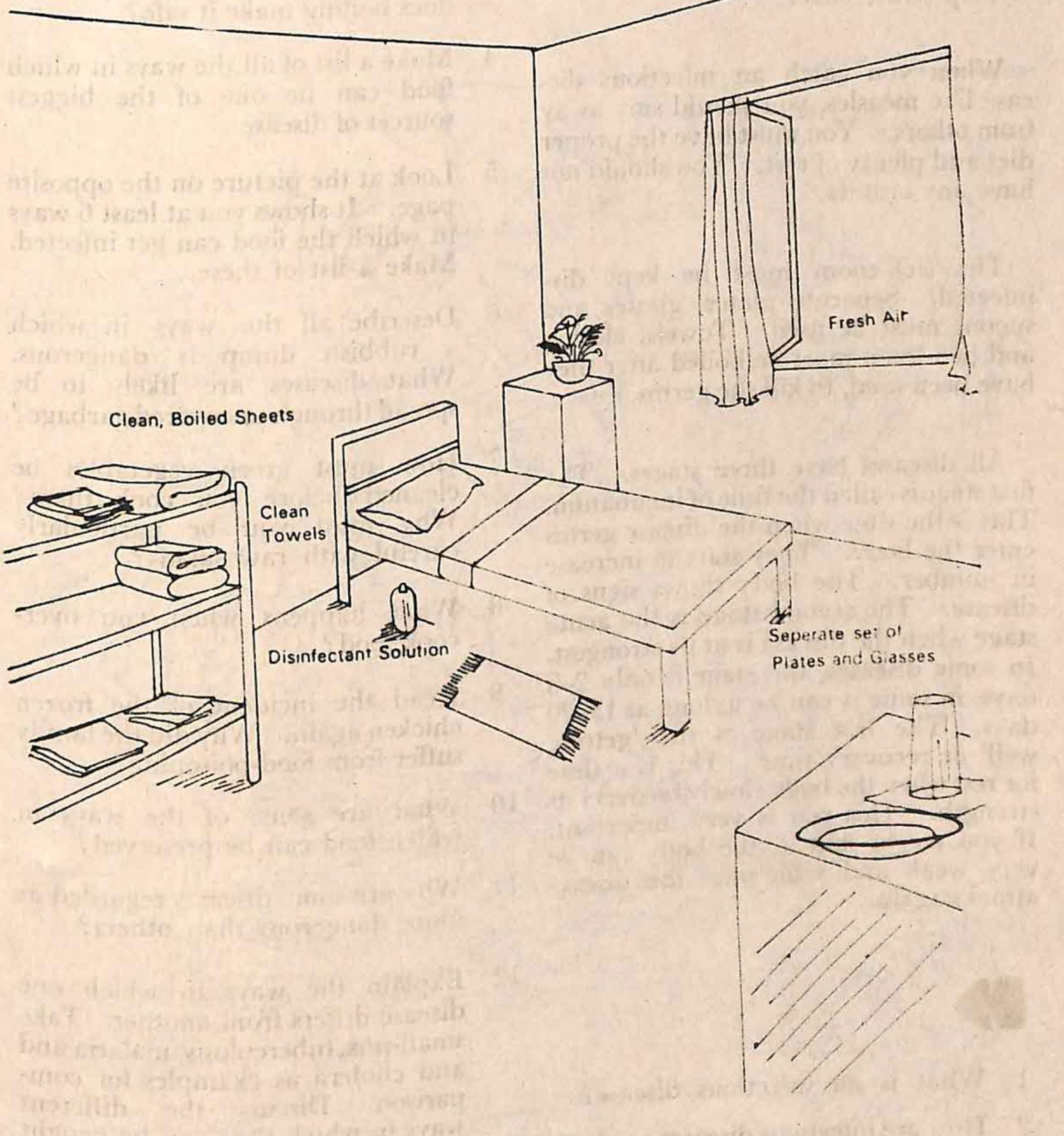
WHEN YOU ARE ILL

All illness needs care, even if it is just a bad cold. It is important to be in a clean, quiet room where you can have plenty of rest.

You must also have a proper diet. Your doctor will tell you what kind of food to have. He will also tell you what you should *not* have! It is important

HOW THE POLIO VACCINE WORKS


Polio Vaccine
Weak form of virus is injected
Virus creates Antibodies to fight it
Fresh doses of virus create more Antibodies
Antibodies kill virus
Virus Destroyed


Fresh Air
Clean, Boiled Sheets
Clean Towels
Disinfectant Solution
Seperate set of Plates and Glasses

A SICK-ROOM

to follow a diet. In this way, you will be giving your body the right food to help you recover.

When you catch an infectious disease like measles, you should stay away from others. You must have the proper diet and plenty of rest. You should not have any visitors.

The sick-room must be kept disinfected. Separate plates, glasses and spoons must be used. Towels, clothes and bed-linen must be boiled after they have been used, to kill the germs.

All diseases have three stages. The first stage is called the time of incubation. This is the time when the disease germs enter the body. They start to increase in number. The body shows signs of disease. The second stage is the acute stage when the disease is at its strongest. In some diseases, this stage is only 2–3 days, in some it can be as long as 15–20 days. The last stage is the 'getting well' or recovery time. This is a time for rest when the body slowly recovers its strength. This rest is very important. If you try to skip it, the body can be very weak and sometimes the disease attacks again.

1 What is an infectious disease?

2 How are infectious diseases carried?

3 Why is tap-water in our country not completely safe to drink? How does boiling make it safe?

4 Make a list of all the ways in which food can be one of the biggest sources of disease.

5 Look at the picture on the opposite page. It shows you at least 6 ways in which the food can get infected. Make a list of these.

6 Describe all the ways in which a rubbish dump is dangerous. What diseases are likely to be spread through uncovered garbage?

7 How must green vegetables be cleaned before you cook them? Why must you be particularly careful with raw salads?

8 What happens when you overcook food?

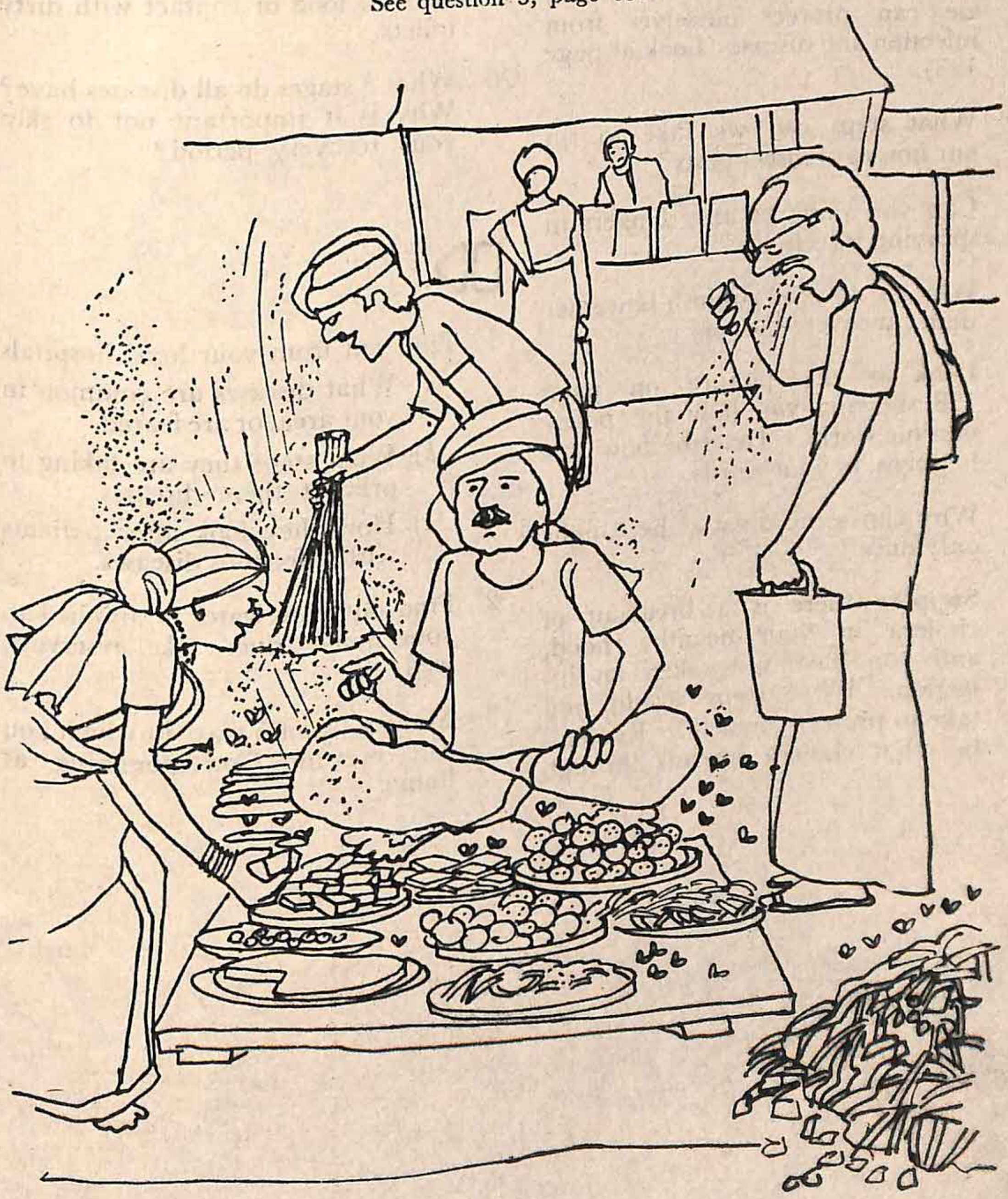
9 Read the incident of the frozen chicken again. Why did the family suffer from food-poisoning?

10 What are some of the ways in which food can be preserved?

11 Why are some diseases regarded as more dangerous than others?

12 Explain the ways in which one disease differs from another. Take small-pox, tuberculosis, malaria and and cholera as examples for comparison. Discuss the different ways in which they can be caught first.

See question 5, page 130



13 Discuss some of the ways in which we can protect ourselves from infection and disease (Look at page 133).

14 What steps can we take to rid our houses of insect pests?

15 Can you think of any dangers in spraying insecticide?

16 Why are covered rubbish bins safer than uncovered ones?

17 Look at the picture on page 128 showing you how the polio-vaccine works. Describe how this happens, in your words.

18 Why can some diseases be caught only once?

19 Suppose there is a breakout of cholera in your neighbourhood, and you have not taken an injection. What steps would you take to protect yourself? Remember that cholera spreads through unclean food or contact with dirty toilets.

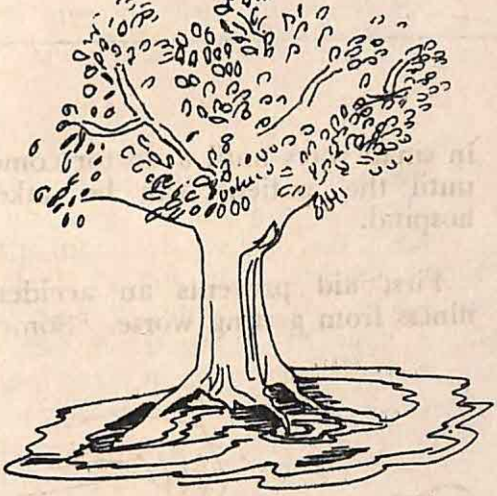
20 What 3 stages do all diseases have? Why is it important not to skip your recovery period?

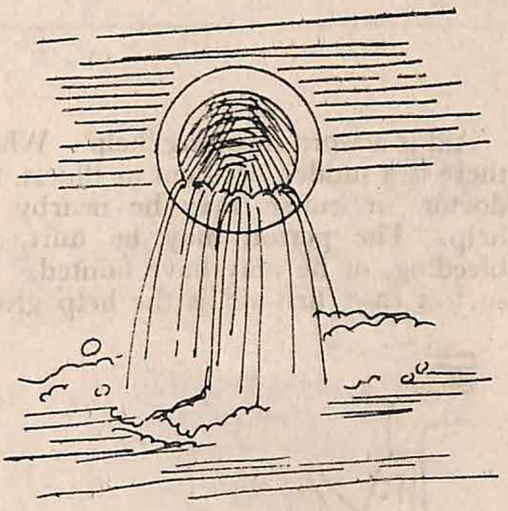
1 Find out from your local hospitals
   a) What diseases are common in your area, or are feared.
   b) What steps they are taking to prevent these diseases.
   c) How they look after patients with infectious diseases.

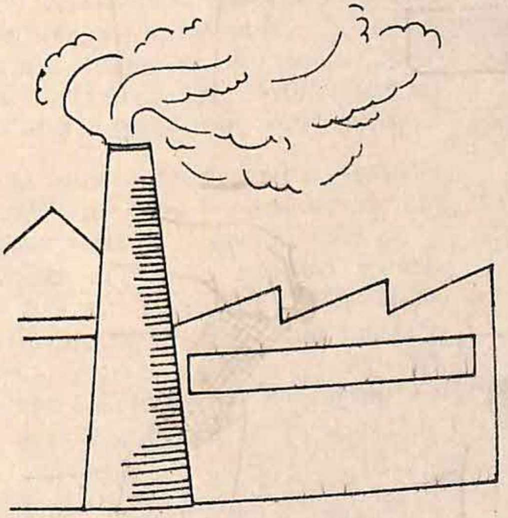
2 Find out how water is supplied to your home (river, lake, reservoir, well)

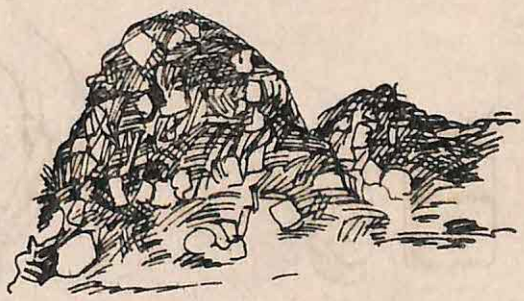
3 Make a list of 5 ways in which you can prevent food poisoning at home.

See question 13, page 132





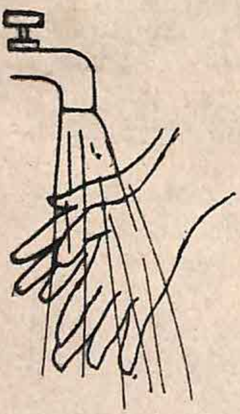


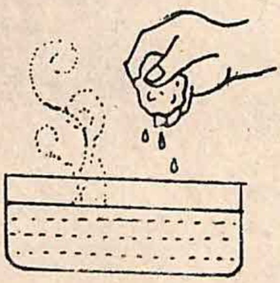


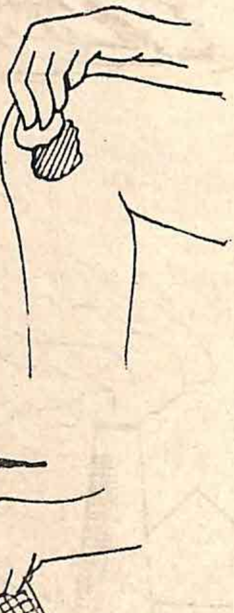
13 FIRST AID

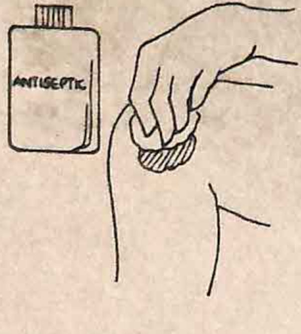
Aid is a word meaning 'help'. When there is a sudden accident or illness, no doctor or nurse may be nearby to help. The person may be hurt, or bleeding, or he may have fainted. In such a case, first-aid is the help given in small ways until a doctor comes, or until the patient can be taken to hospital.

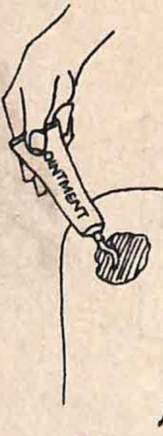
First aid prevents an accident or illness from getting worse. Sometimes

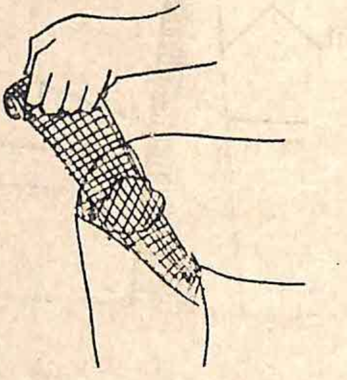












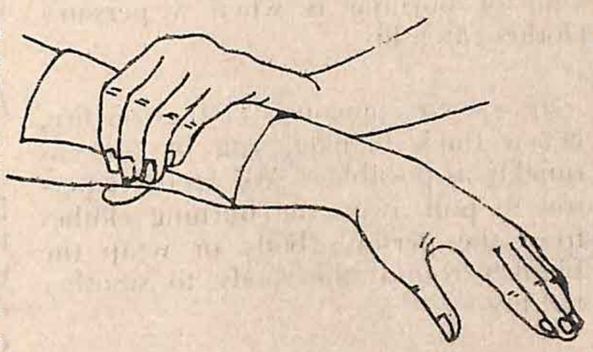
it can even prevent death. In this chapter, we will discuss some kinds of first aid. You may not be old enough to give all the help necessary, but you can help people do these things.

Bleeding

If someone falls or gets a sudden cut, there is bleeding. If the hurt is small, only a little blood will be lost. If it is a small scratch or cut, it is enough to apply tincture of iodine on it. Some wounds may be muddy. In such a case, wash your hands first. Boil a little water and wipe the skin round the wound carefully with cotton-wool dipped in the water. Rub out the dirt gently over the wound. Keep changing the dirty cotton-wool swabs. Now take another piece of cotton-wool or thin, soft cloth and dab the wound with an antiseptic solution. When the antiseptic has dried on the wound, apply some tincture of iodine on it. You can also use an antiseptic ointment. Now cover the wound loosely with gauze so that flies and dust cannot settle on it.

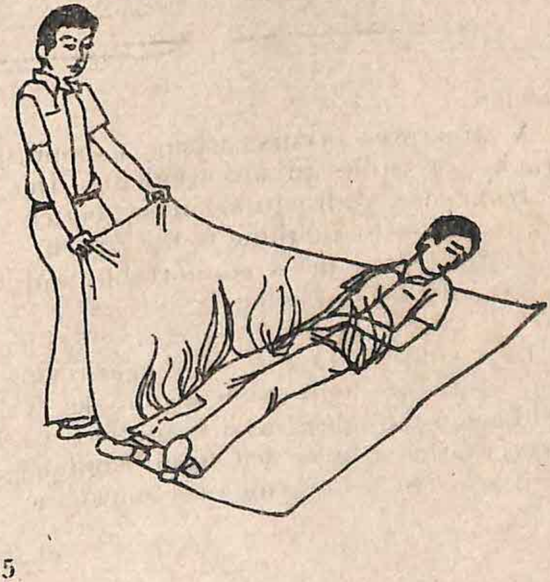
A dangerous disease called tetanus can strike in some wounds. It is particularly risky if a person falls on a public road or on a ground where animals graze. Cleaning with antiseptic helps but it is safe to take tetanus injections. You must try to get the person who is hurt to a doctor as quickly as possible for a tetanus injection.

Sometimes, a lot of blood may flow from a wound. You may not be able to stop it. One way of stopping this bleeding or slowing it down is by putting pressure on the wound. Put a clean piece of gauze on it; hold your hand firmly over it. You will have to hold on until the doctor comes. Change the cloth if it is soaked with blood. If you do not have a clean cloth, tie one side of the wound tightly with cloth to stop the blood from flowing.



Burns

Burns occur when we touch something very hot, or when a boiling substance falls on our bodies. The worst



kind of burning is when a person's clothes catch fire.

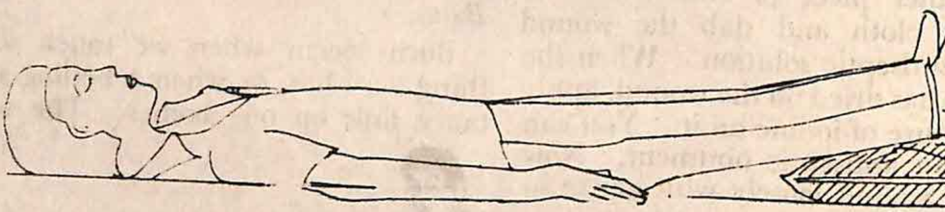
If you see someone's clothes on fire, get a thick blanket, rug or mat as quickly as possible. Ask an older person to pull away the burning clothes from the person's body or wrap the blanket round the body to smother the fire.

When the fire has been smothered, cover the burn with a clean dressing. Do not try to peel off cloth that is stuck to the burn. Take the patient to a doctor as quickly as possible.

If it is a small burn, pour cold water on it for a few minutes. If there is a blister, do not break it. Wipe the burn dry gently.

Fainting

A person can faint if he has lost a lot of blood. Sometimes, a person may faint from fear, or hunger. When this happens, stretch the person on his back. Raise his legs a little on a brick or a pillow. Loosen all the tight clothing so that he can breathe easily. Move the person carefully to a place where there is plenty of fresh air. If there is a crowd round him, ask people to move away so that he can have fresh air. Sometimes it helps if you sprinkle cold water on the face and slap it gently with water. When the person comes out of the faint, give him a cup of hot, sweet tea or coffee.



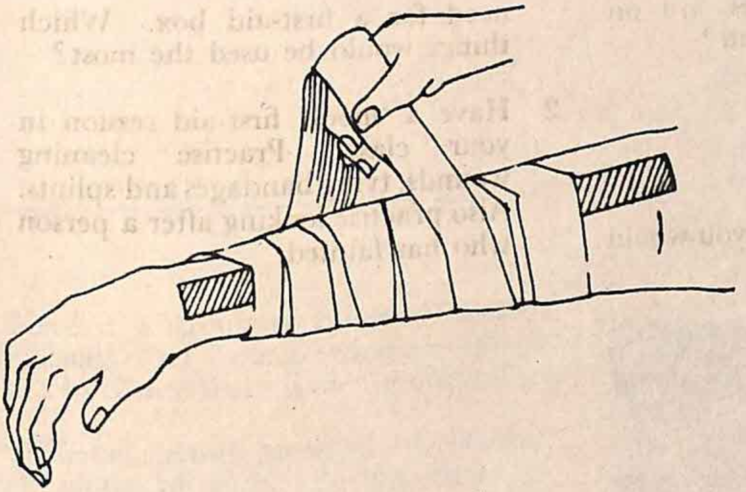
Fracture

A fracture occurs when a bone cracks or splits in an accident. In a bad case of fracture, it is better not to try to do anything to the patient. Just make sure he is comfortable and call the doctor immediately.

In a simple fracture of the arm or leg, you can help someone make a splint. A splint is a stiff support to prevent the arm or leg from bending. You can use a foot-rule or a magazine as a splint. The picture shows you how to help someone tie the splint. *Never* try to move the bone or push it back in its place.

Bleeding from the nose

You can try to stop this quite easily. Ask the person to sit down and bend his head forward. Now press his nostrils together for about five minutes. Let him breathe through his mouth. Do not allow him to blow his nose.



A FRACTURE SPLINT

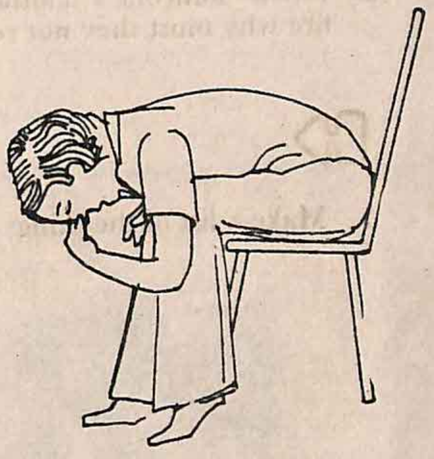
Insect bites and stings

Apply a mild calamine lotion on the bite. If the sting has been left in the wound, take a pair of tweezers and ease it out. Dab the place with antiseptic solution and apply calamine on it.

Dog bite

Dog bites can be dangerous if the dog has a disease called rabies. Treat the bite as you would any ordinary wound. Report the bite to the doctor at once. If the dog is found to have rabies, he will give the person who is bitten a course of injections.

1 Why is first aid sometimes necessary?



BLEEDING FROM THE NOSE

2 Here are some simple accidents. What would you do if you were around when they happened?

- *a*) A boy falls on the street and cuts his knee.
- *b*) A man faints in a factory near a rotating machine.
- *c*) A parrot pecks and injures a child's finger.
- *d*) A child cuts his hand with a blade.

3 In a bleeding wound, why is it better to tie a gauze bandage loosely than tight? Why is a bandage tied at all?

4 Why and when do you have to take tetanus injections?

5 When a lot of blood flows from a wound, one way of stopping it is to hold your hand firmly over it. How does this help?

6 When someone's clothes are on fire why must they not run?

1 Make a list of the things you would need for a first-aid box. Which things would be used the most?

2 Have a 'mock' first-aid session in your class. Practise cleaning wounds, tying bandages and splints. Also practise looking after a person who has fainted.

Here is a group of rainforest trees. We usually find them growing on clayey soil, and where there is plenty of rain.

Different plants grow well in different kinds of soils. A soil that is suitable for one kind of plant may not be suitable for another.

Green plants as a whole cannot be grown without soil. They get all their nutrient mineral salts from the soil. This mineral matter is formed when the rocks break and crumble and become a part of the soil. Some of these mineral particles dissolve in the soil water. This solution is wrapped round soil particles. When the roots absorb water from the soil, they absorb the nutrients from around the particles.

Soils contain different elements. They contain oxygen and carbon dioxide in a dissolved form. Mineral matter in soils consists of gravel, sand and mineral iron. Some soils contain silt and clay.

Different soils contain different amounts of gravel, sand, iron, silt and clay. For example a clayey soil has more clay and silt in it than gravel and sand. A sandy soil contains gravel and sand.

If you mix clay and sandy soil with a little organic matter, you get a mixture called a *loam*. Loams make a rich soil and are used for cultivating many crops.

How does it help to mix soils? What happens when they are mixed? The answer is that soil substances have different qualities. We saw in Book 3 how sand allows water to filter through. This is because sand and gravel particles are large and are loosely packed together. You can pour dry sand from one tin into another. You cannot 'pour' clay in the same way. The particles of clay and silt are small. They stick close together. Because of this, they can hold water and prevent it from passing through. If you mix clay and sandy soil you can get a soil mixture which has the qualities of both. The sand particles allow plenty of air to circulate. The clay holds moisture and prevents it from drying up fast. At the same time a sandy soil makes sure the water drains through. If it did not, the roots would rot in standing water.

Not all crops grow well in loam. Certain crops grow better in a wet, clayey soil. Paddy and groundnut are examples of these. Paddy needs standing water. Groundnut plants do not need as much water.

Vegetables grow well in loams. The decayed leaves and animal matter in soils makes it rich. Chemical fertilisers are also added to clay soils to make them rich. You will learn later about nitrates. These are added to help the soil make more nitrogen. Nitrogen is a gas that plants absorb and use.

ROTATING CROPS

Some farmers do not cultivate the same kind of crop in the same soil every year. A crop as it grows absorbs different kinds of minerals. The soil becomes poor in these minerals. A paddy crop for example, uses certain minerals from the soil. It takes some time for the soil to regain these minerals for the next paddy crop. So the farmer grows a crop of, may be, peas and beans. These plants may not need the minerals which the paddy crop has used. They may also help make the soil rich in nitrogen. In time, these plants are harvested and the new paddy crop grown. By this time the soil has been able to make the minerals needed for the paddy crop.

In crop rotation only one kind of crop is grown at a time.

The other way of putting back lost minerals is by using fertilisers. These fertilisers are made from chemicals. They are also made from mineral wastes in mines. In this way, farmers can use the same land. He can grow the same crop in a chain. After harvesting the old crop, he leaves the field bare for a while. (The farmer's word for leaving a field bare is 'fallow'.) He then treats it with fertilisers and turns up the soil with his plough. He gives the soil time to absorb the fertiliser before he plants the next crop.

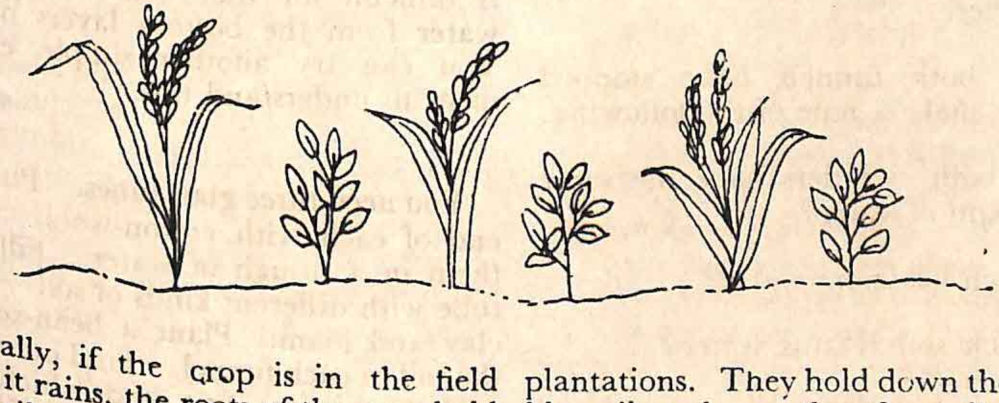
Another way of farming is called 'shifted' farming. A piece of forest-land is cleared and crops planted on it. When this crop has been harvested, the farmer moves to another piece of forest and clears it. He plants the next crop there. He leaves the old field fallow to help it recover the soil nutrients. When the crop in the new field has been harvested, he may go back to the old field. He thus shifts from one field to another.

This kind of farming is only possible where there are large areas of land. Most of our farmers farm in small fields.

HOW SOIL IS CONSERVED

The upper layers of soil in a field are being constantly washed away by water from heavy rain. Rivers also wash away layers of soil. In some places, strong winds can sweep off top-soils.

In Book 4, we learnt about some of the ways in which soil is conserved. Tree plantations help to hold soil.



Normally, if the crop is in the field when it rains, the roots of the crop hold the soil and prevent it from being washed away. Some crops are planted in such a way that space has to be left between one plant and another. To prevent soil in these spaces from being washed away, farmers plant smaller plants like grass.

Weeds are normally thought of as a nuisance to the farmer. But they have their uses in some rubber and coffee plantations. They hold down the valuable soil and are therefore allowed to remain.

We have seen at the beginning of this chapter, how different soils suit different plants. Actually, it is not the soil alone that is important. The climate, the changes in weather, knowing where water is available and how it can be used—all these are important in growing the right crop in the right place.

A farmer must know as much as possible about the soil on which he farms. Can the soil retain water? Does it allow water to drain through? He must decide which of these suits the plant.

Drainage

You can do a simple experiment to find out about this important quality, drainage. Place a funnel each on two measuring cylinders. Fill one funnel with dry sand, and the other with dry, powdered clay. Now pour a cup of water on the soil in each funnel. The water will drain through and drip into the cylinder.

When both funnels have stopped dripping, make a note of the following:

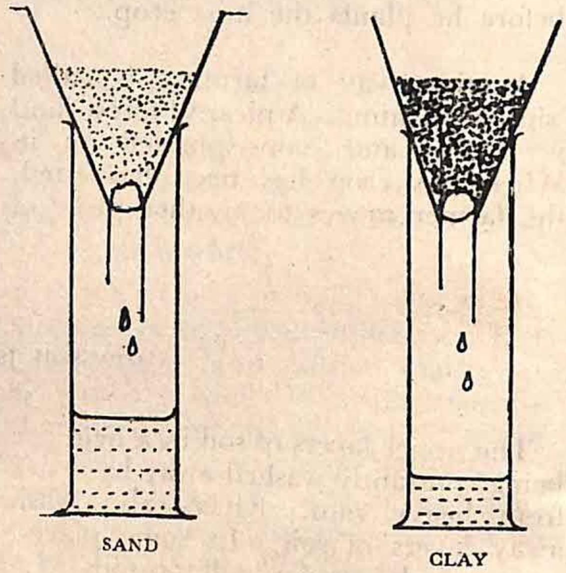
1 Do both cylinders have the same amount of water?

2 Which has more water?

3 Which soil retains water?

4 Which soil does the water drain through faster?

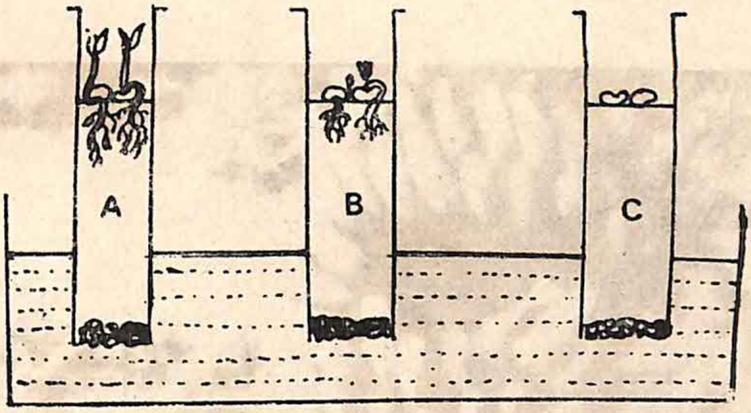
5 What does this tell you about sand and clay?



How easily can the plant absorb water?

This is another fact the farmer has to know about. Plants cannot survive if it is difficult for the roots to draw up water from the bottom layers of soil. You can try another simple experiment to understand this.

You need three glass tubes. Plug one end of each with cotton-wool. Stand them in a trough of water. Fill each tube with different kinds of soils—sand, clay and loam. Plant a bean-seed in the soil in each funnel. Find out which seed germinates first and which last. Which seed did the water get to first?



1 Some plants that grow well in one place may not grow well in another. Why is this so?

2 In what ways do soils differ?

3 What is loam? Is it usually a natural soil or does it have to be made?

4 Why do the top layers of soil have to be protected?

5 What is crop-rotation?

6 What is 'shifted' planting? Why can it be practised only where there are large areas of farming land?

7 What mineral matter is soil normally made up of?

8 Why does the farmer need to know about drainage of the soil?

9 Why does he need to know how easily the roots can draw up water from the bottom layers of soil?

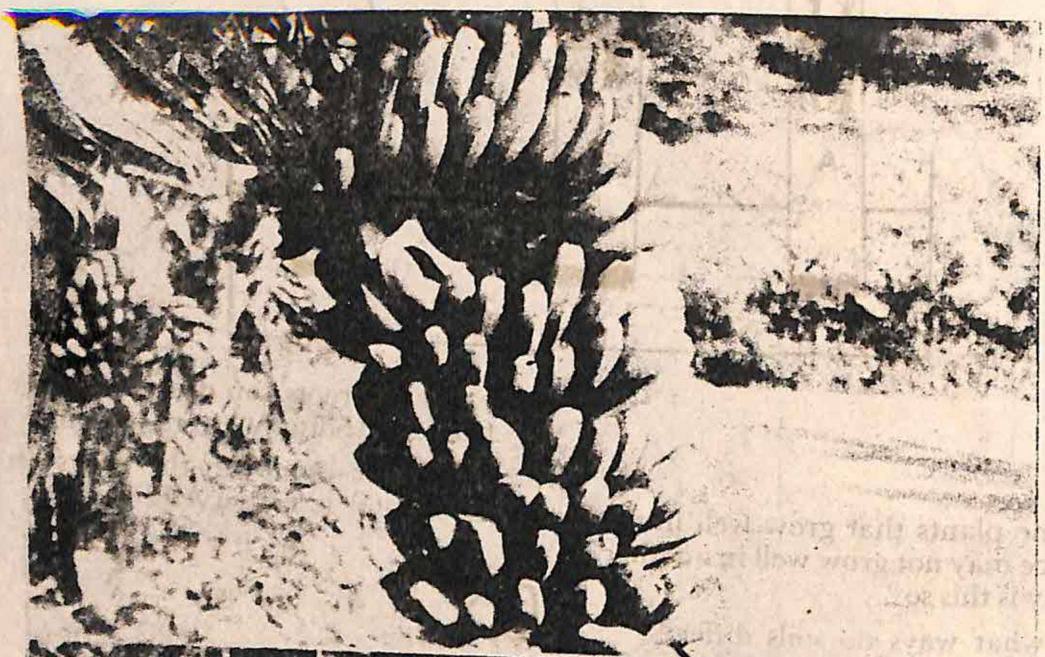
10 What are some of the ways in which soil is conserved?

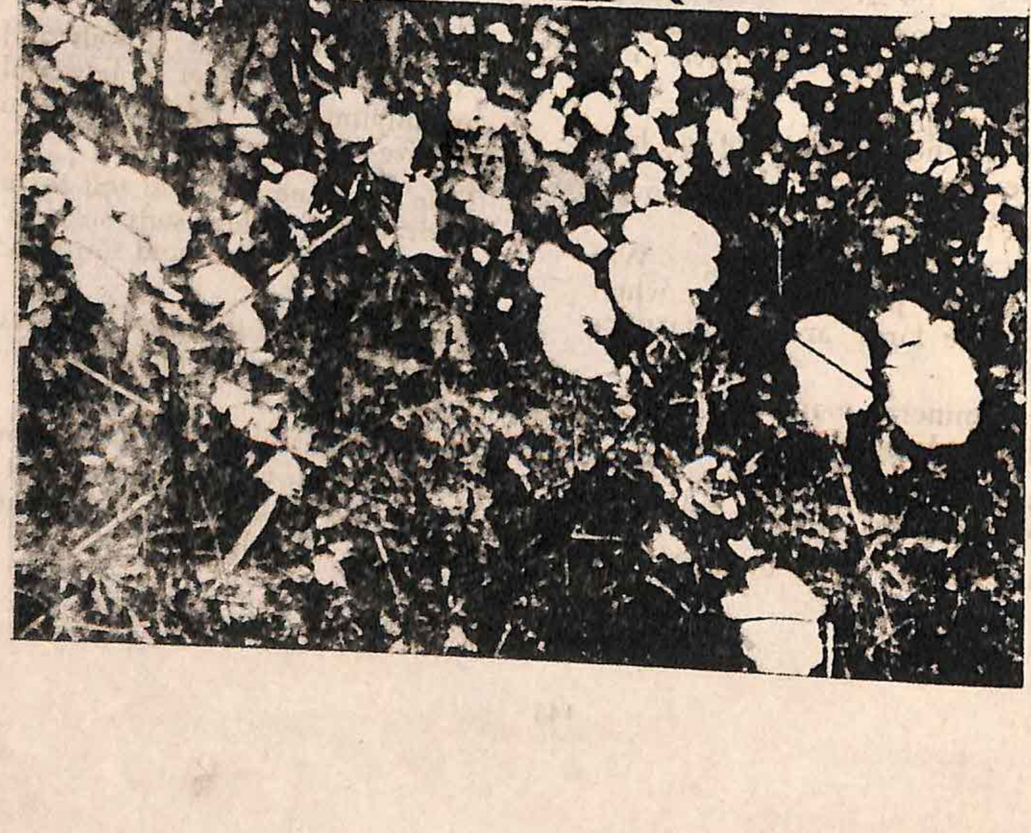
1 Take different kinds of soils and examine them under a powerful magnifying lens. Make a note on the size of the particles, etc.

2 Take the same soils and test them for drainage. Which soils 'suck up' water fast? Which hold water for a long time?

3 Find out how soil settles in layers when poured into a glass cylinder of water.

4 Which of the soils in your collection is sticky when you add water to it. Which soils make a hissing noise as they absorb water?





15 UNDERSTANDING NATURE

Without man, the world would be very different today. The flora and fauna would be there. The Earth would be a mass of water, plant-land and desert. Some animals would be greater in number than they are today. There would be no towns or cities, or any kind of settlement.

Man has changed the face of the Earth right from the beginning. The first men cleared forest-lands and grass-lands so as to be able to live on them. They learnt about fire and all its uses. They learnt to use metals and to mine under the earth and in water for it. As time went on, men travelled, first across land, then the seas. Today we can even travel by air. They built towns and cities. **Men** built bridges, canals and factories. They made machines. They learnt to make things like glass and plastic and cloth.

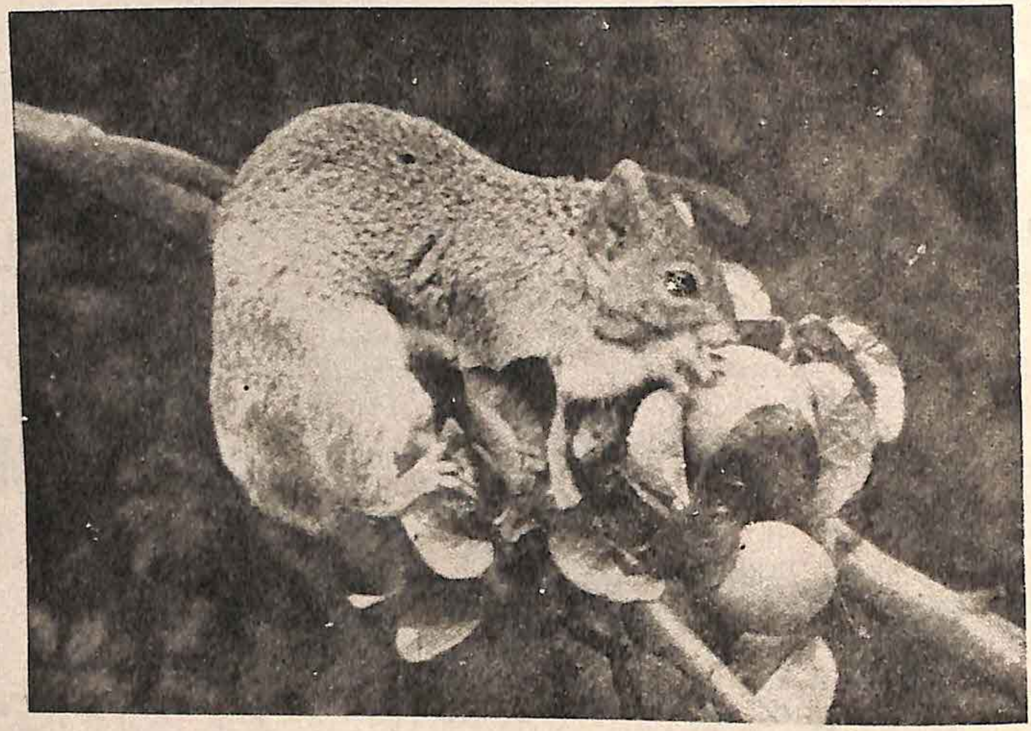
MAN AND NATURE

All this had a deep effect on nature, the natural world of plants and animals. Food was our first need, so animals were hunted for food. We still depend on animals for this. The sea was also a large source of food. In the same way men learnt methods of agriculture so that more food could be got from plants at the right time.

A second great need of men was shelter. Again, the wonderful things in nature provided the answer—wood, grass, metal and the minerals of the soil.

And so the needs grew. New and wonderful things were being discovered all the time. Earlier we learnt about the balance of nature and how we have upset it many times. We have thoughtlessly hunted animals for meat, fur, skins and for many other purposes. Vast areas of beautiful forests have disappeared because the trees have been cut down for timber.

Slowly, we have begun to realise the great harm done to the world of nature by our actions. Many animals disappeared completely from the face of the earth because nothing was done to protect them. There are so few tigers



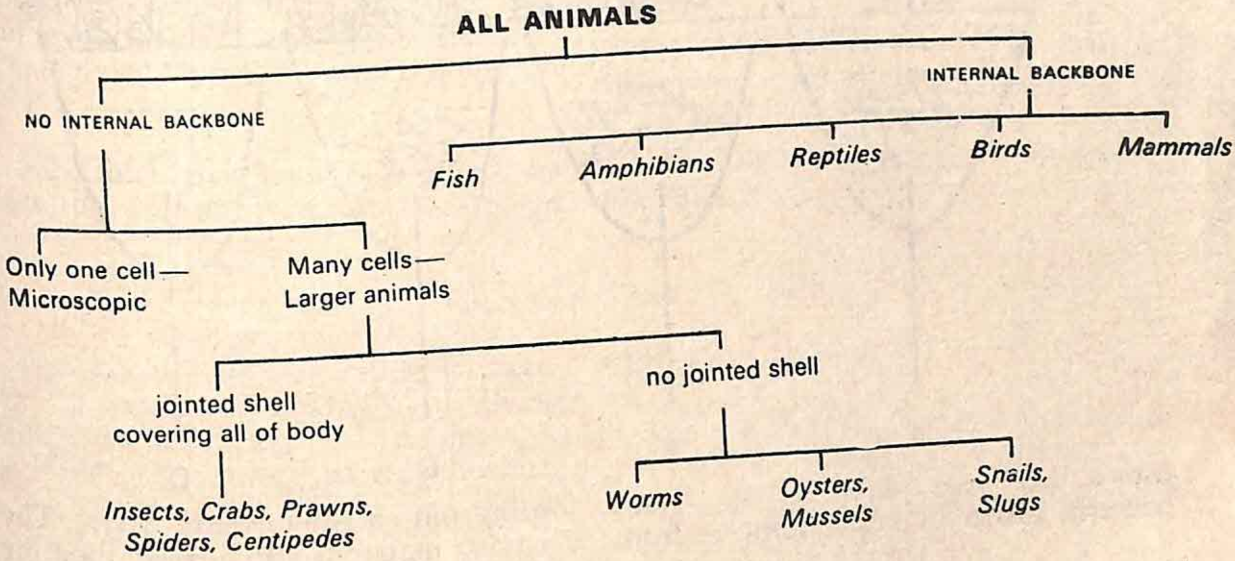
in the world today that they are in danger of disappearing too.

Whale-hunting was once a great and profitable activity. The blue whale was a precious source of food, fuel and other materials. Literally thousands of whales were killed to serve our purposes. This was so uncontrolled that the whale population was in danger of being wiped out.

Recently laws have been passed to protect whales. Only a limited number of whales can be hunted every season. This is also true of tigers, lions, the koala bear and many other animals. They are called 'endangered animals', that is they are in danger of disappearing from the earth. So the law protects them.

To help us study this balance of nature better, scientists have divided the animal world into types. The main distinction is between animals with and without backbones. See the table below.

We already know that the plant world is also divided into classes of plants. The main classes are flowering and non-flowering plants. Within these there are millions of species.



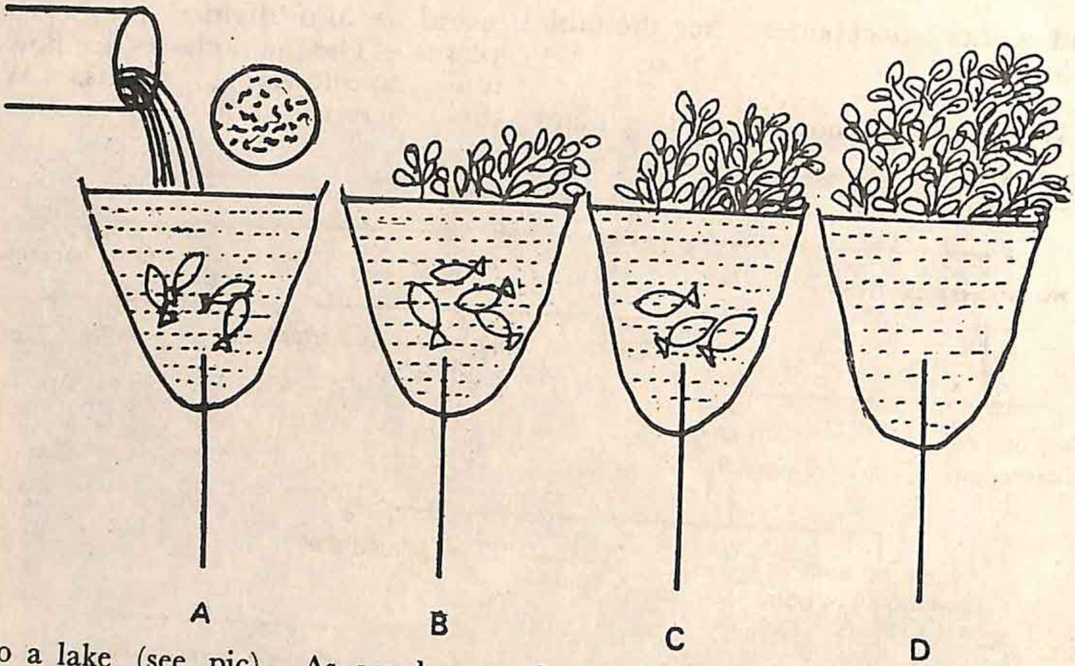
ORGANIC MATTER

Studying nature in this way has shown how living things depend closely on one another. We learnt about this in an earlier chapter. Let us look at one interesting aspect of this.

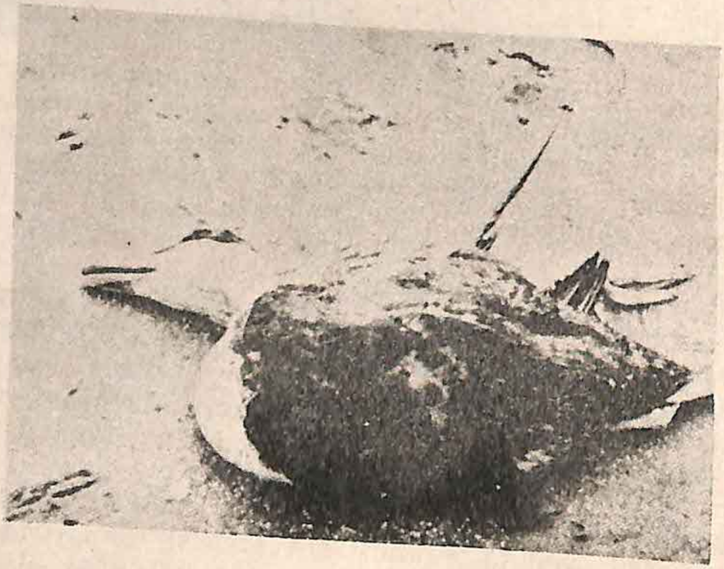
We know that plant and animal remains make organic matter. This becomes a part of the soil. The organic matter is the *main source of food* for our world. Nitrates are formed by the bacteria from the organic matter. As a result of the action of the nitrogen, salts are released from the soil and taken up by the roots. The cycle of organic matter (or the nitrogen cycle) keeps the plant alive and growing. If the nitrogen cycle is disturbed, plants would slowly die. Food from plants would become more and more scarce. Living things that depend on plants would also not be able to survive.

Organic matter is important to us in another way. We know that animals that live in water depend on oxygen in the water to breathe. If this oxygen is removed, these animals would die.

Quite often organic waste materials are carelessly dumped in lakes and rivers. Sewage water may also be channelled



into a lake (see pic). As we know, bacteria grows in large numbers from feeding on organic waste (A). The decaying matter is also healthy food for



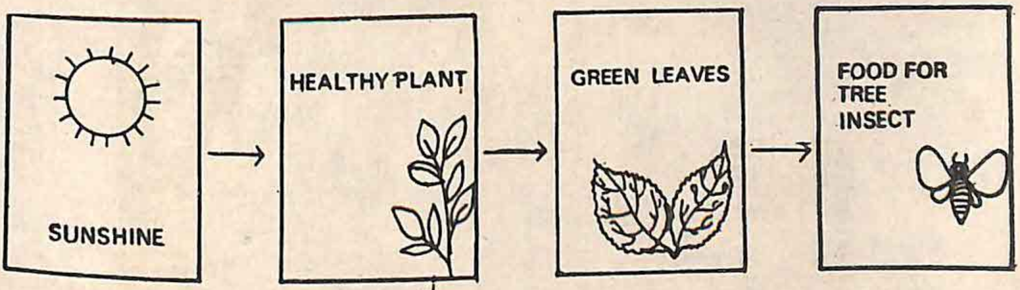
DEATH FROM OIL POLLUTION

small green plants like algae (B). These plants, therefore, increase in numbers by leaps and bounds. They take the oxygen out of the water (C). They even choke every space of water. The fish die for lack of oxygen. The result is a 'dead' lake caused by water pollution (D).

Sometimes poisonous materials have been thrown into rivers and seas. Some chemical wastes from factories find their way into the water. Oil is another killer material. If an oil tanker explodes in water, or if oil wastes mix with water, it can destroy life in the sea. On page 148 is a picture of a duck that died as a result of oil pollution. The oil clogged its feathers and the bird could not move. It struggled for a while and then died.

LINKS IN NATURE

Life in the world of nature is therefore a series of chains. All living things are linked together in some way or other. We have just seen how an action at one end of the chain has a result at the other end. Here is a simple diagram of one of these chains.

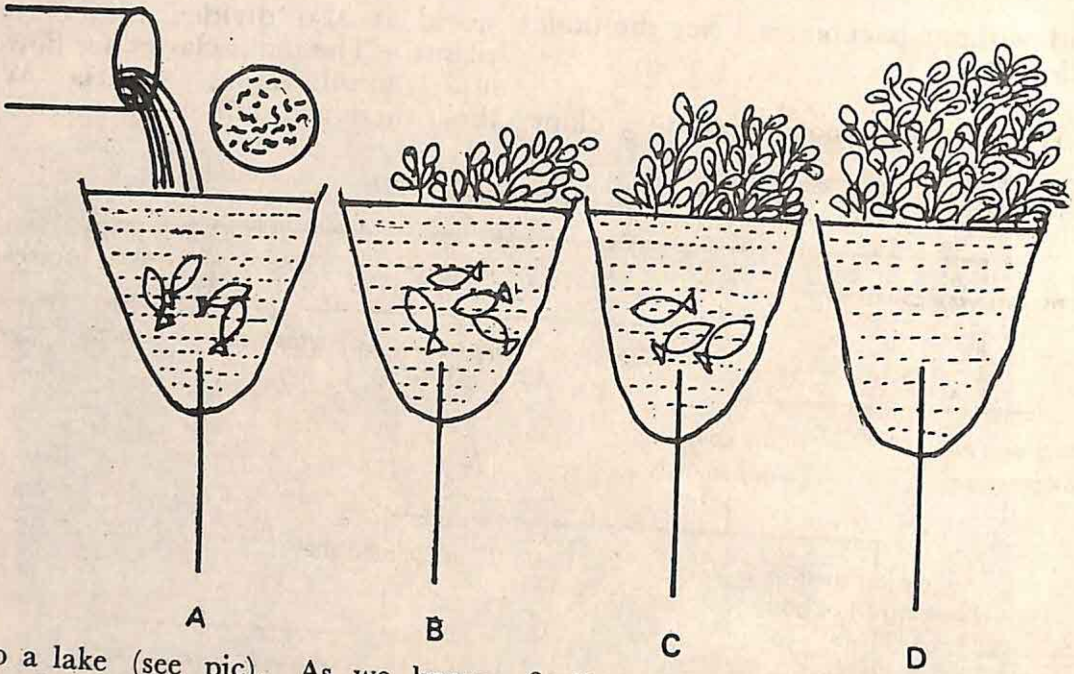


Many events in nature can themselves upset or break these chains. If the weather changes sharply, it has an effect on life. Some living things may die because they cannot adapt to the sudden change. Floods, avalanches, earthquakes and droughts can also destroy life suddenly.

What is our part in all that is happening around us?

1 The first thing is to understand that we have an enormous influence on our environment. To a large extent, we can change it or modify it. We can control some things, such as pollution. We can also control the ways in which we get rid of wastes.

2 To be able to preserve the world of nature we have to *understand* it. We must study links between things. We must understand how a certain action has a certain result. Most important of all, we must be able to tell what is *most*



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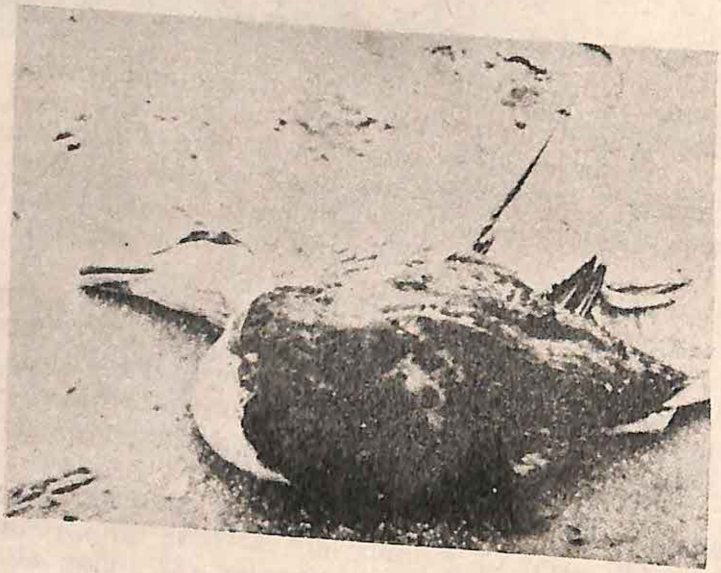

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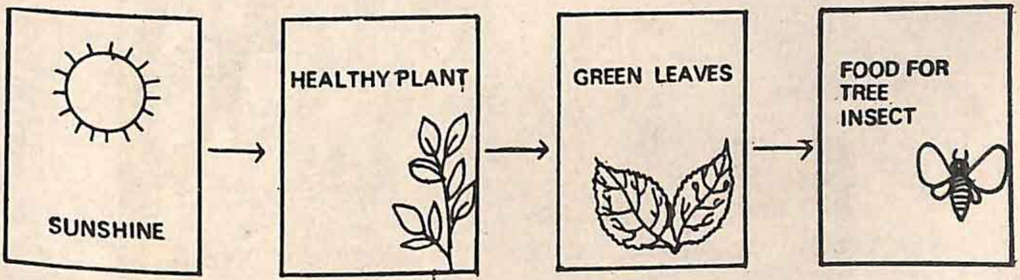

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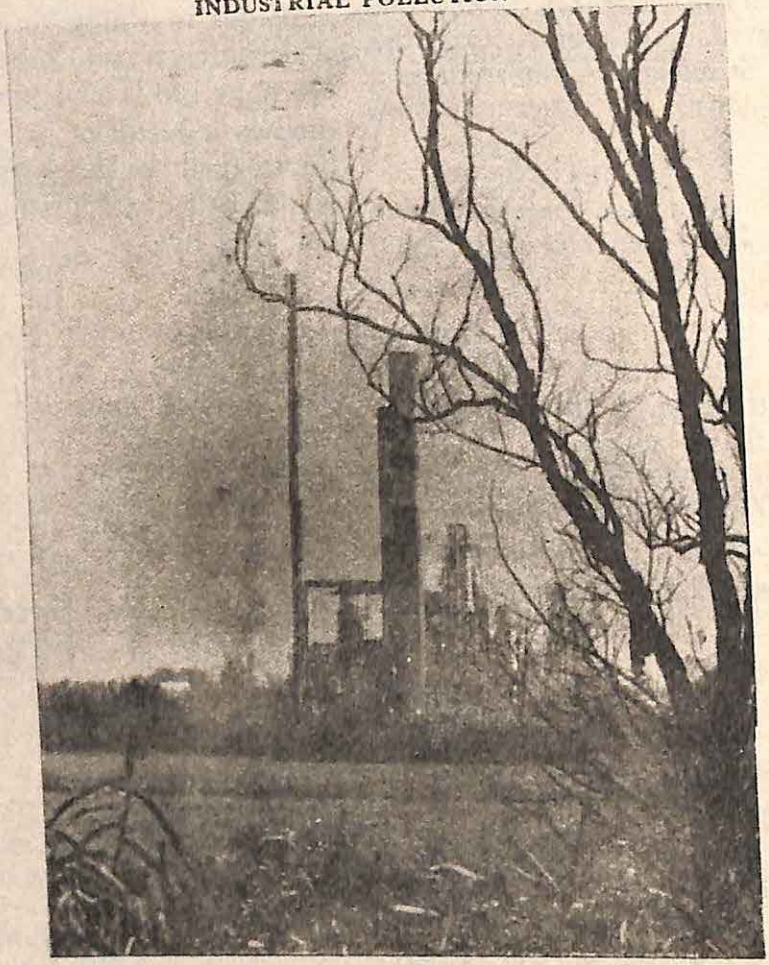
INDUSTRIAL POLLUTION



likely to happen if a certain thing is done now. For example, if we decide to use more and more plastics in the next five years, what will its effects be twenty years later? The study of our environment helps us understand these things.

3 We can help to conserve things in nature. We can help *put back* the resources that nature loses from

time to time. For example, soil loses some of its minerals when crops are farmed on it. It must also be 'fed' with organic matter to keep the nitrogen cycle going. We can use fertilisers to plough back precious minerals and nutrient salts into the soil.

4 Some things that we do today may seem to be in a good cause. The *later* effects may be bad or harmful. For example, we use chemicals to destroy plant pests and weeds. In this way we can grow healthy crops and also protect animals. But we do not know what the effect of this will be years later. The chemicals may not have a good effect on plants in the long run. All action must therefore be carefully taken with the future in mind.

5 As men who are able to think and do, we have made wonderful things for today's world. Now we must remember that everything ages in time. Some metals rust. They may lose the forces they had when they were first made into

WATER POLLUTION

things. Wood can rot and decay. Plastics break or melt. When things become useless for us we have to throw them away.

Now things which are thrown away do not disappear into thin air! Some things rot or *decompose*. They become organic matter. This organic matter, as we know, can always be used. Wood and paper are examples of such materials. But plastics do not decompose. It is wonderful to think of making more and more things with plastics. But we must remember that plastic wastes are difficult to destroy. It is also expensive to re-use them. In fact, many plastics cannot be re-used or re-cycled.

It is important for our life, and life around us, that we work *with* nature, not against it. We have helped rid the world of many diseases, and to keep them under control. We have found new ways of growing healthy crops and rearing healthy animals. We are trying to conserve nature's precious water and mineral resources. Our needs grow and we will have to depend on the natural world to answer these needs.

The answer is therefore to **help** keep the balance, use and restore.

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